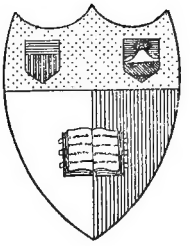
A BOOK ABOUT THE BEE

HERBERT MACE



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" If we value diligence and indefatigable industry ; judgment, prudence, and foresight ; economy and frugality ; if we look upon modesty and diffidence as female ornaments ; if we revere parental affection—of all these, and many more virtues, insects in their various instincts exhibit striking examples."

KIRBY : *Introduction to Entomology.*

WATER CARRIERS AT WORK.

BEES SEARCHING FOR A MISSING QUEEN.

A BOOK ABOUT THE BEE

BY
HERBERT MACE

WITH 24 ILLUSTRATIONS ON ART PAPER,
FROM PHOTOGRAPHS BY THE AUTHOR

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PREFACE

"Of books about bees," it may perhaps be said, "there is surely no lack."

Whilst it may at once be admitted that there are many books dealing more or less with bees, there is one fact to be noted about them. They are nearly all intended as a guide to practical bee-keeping. Out of a list of thirty-five "bee books" which I have looked over, no less than twenty-eight are practical handbooks. Five are highly scientific works, and the other two are almost of a metaphysical nature, in that the bees are only used as a peg on which to hang a dissertation on human life and conduct.

Everyone does not want to keep bees; few people feel intensely interested in detailed descriptions of the internal anatomy of the insect; while it is not every reader who is pleased, on getting half-way through a book about bees, to find that under the sugar coating of a peep into the wonders of Nature is a pill designed to remedy the evils of Society. These are all legitimate works, very good and useful to those who need them, but, if one may judge from the

interest shown by one's friends and neighbours when the subject of bees is introduced, a plain account of the life and death of the busy occupants of the darksome hive would be more readily welcome.

Inspired by strong affection for these wonderful little creatures, I have endeavoured to supply such an account.

HERBERT MACE.

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I

THE GENEALOGY OF THE BEE

THE history of a nation or biography of an individual is incomplete without some information about ancestry and contemporary relations, and it often lends light to the subject immediately dealt of to treat, even a little minutely, of subjects closely akin to it. It will be as well, therefore, if I say something about the near relations of the honey-bee.

The great order Hymenoptera contains a most varied assortment of insects, whose habits differ to a remarkable extent from those of every other order. In Great Britain alone there are some three thousand distinct species, their common character, widely though they differ in many other points, being the possession of four membranous wings, the lower ones provided with a set of hooks, which, when the insect is in flight, are affixed to a groove in the hind part of the

upper ones. This arrangement transforms two otherwise small wings into one broad expanse. Even so, the amount of wing area in the bees, particularly in the near relations of the honey-bee, the bumble-bees, is very small in comparison with that of most other insects. The butterflies and moths have wings of vast expanse; the swiftly gliding dragon-flies have long, firm pinions. Even the beetles have, packed away under the horny covering which takes the place of the upper pair of wings in most insects, a longer pair of wings than those possessed by the bees. Yet, notwithstanding this, the flight of bees is the most rapid and sustained of any. When we bear in mind that the wings of bees have to support not only the weight of the insect, but also at many times very great loads of honey and pollen, we cannot help marvelling at the apparent uselessness of such small wings for the purpose.

Of late years the problem of flight has been very much to the fore. The present generation may, perhaps, pardonably claim to have solved it for the human race, at least so far as the general principles are concerned. Yet we have certainly not succeeded in approaching to anything like the power possessed by the bees. An enormous amount of plane area is found necessary for the support of even one man, and this is only achieved by the fortunate inventions of clever engineers

who have succeeded in constructing engines which develop a high power with very little weight.

It is obvious that there must be some other reason than mere size of wing to account for the powerful and direct flight of the bee. Doubtless shape has much to do with the matter. In the butterflies and moths, the swiftest fliers, such as the "hawk" and "swift" moths, have long, pointed wings, and in the bees we observe the same character. The broadest portion is very close to the base, while the tip is fined off to an absolute point.

Another striking character of hymenopterous wings, especially those of bees, is the great thickness and rigidity of the anterior margin, the front boundary of the wing. Every wing is made up of two layers of membrane, one above and one below. These membranes are supported by a framework of tubing, known to entomologists as "nervures," and these nervures are filled with air during flight. The result of this arrangement is that the wing is kept as taut as a drum, and thus offers the greatest possible resistance to air pressure.

But even this well-designed mechanism would be insufficient to serve the purpose of such prolonged and powerful flights as are undertaken by bees were it not allied to exceptional motive power. This motive power is supplied by extremely rapid vibrations of the wings. The

force of these movements may be readily understood if one places a hand close to a bee engaged in ventilating the hive. It will be found that quite a strong current of air is set up by them. Although it is well enough known to the bee-keeper, probably the layman hardly realises the kind of weather that bees will often be abroad in. When honey is to be had for the gathering, hardly anything is too bad for them. I have seen them pouring out of the hive in a rain-storm, regardless of the drops which must beat against their wings, and it fills one with wonder to see them coming home in the teeth of a south-westerly gale, laden to the decks with honey and pollen, yet gliding swiftly and easily down to the hive entrance as though the breeze were a mere zephyr.

These hooked or " married " wings are, therefore, the common characteristic of hymenopterous insects, but the order is divided into three sub-orders, and the section to which the bees belong is known as the *Aculeata*, from the possession by its members of a specialised weapon of defence in the shape of a sting. This sub-order comprises four tribes—the ants, the sand-wasps, the true wasps, and the bees.

Although each of these tribes contains species which live solitary lives, their outstanding characteristic is the presence among them of many which live together in more or less permanent communities, a curious outcome of

this arrangement being the development of a third, or neuter sex.

It is among the ants that the most wonderful social organisations are found. In their communities there is the most remarkable division of labour, some members being developed as warriors, others for the more domestic operations. The ant communities are permanent, in which respect they are like those of the honey-bee. The wasp colonies are annual, being commenced each year by a solitary female and dying out at the end of the summer.

The same feature is common to the bumble-bees, which are the nearest relatives to the bee, their common character being the fact that they feed on honey and pollen, whereas the wasps use animal matter, such as flies, to supply the nitrogenous matter needed for their energy.

The bumble-bees' colonies are not nearly so extensive as those of the hive-bee. Few of them contain more than 200 to 300 individuals in the height of the season, whereas a colony of bees numbers anything from 30,000 to 60,000.

Moreover, the bumble-bees fall far short of the hive-bee in the matter of constructing their nests. While the bumble-bees do little more than clean out a ready-made hole in the ground and line it with moss, the hive-bee constructs those wonderful hanging combs which have excited the wonder of mankind from time imme-

morial. Bumble-bees do secrete a certain amount of wax, but it is cast into a very crude form, the few cells made of it being merely stood upright on the ground to form pots for the reception of honey.

There are several kinds of honey-bee found throughout the world, but *Apis Mellifica* is the most widely spread and commonest of all the *Apis*. So widely is it distributed that it is almost impossible to ascertain in which country it first made its appearance. In Palestine it is found wild, making its hives in rocks and holes. The variety there found has a reputation for viciousness, so that the Psalmist's "They came about me like bees" has a more pregnant meaning than would be associated with the comparatively mild and inoffensive bees of Europe.

In Italy a variety is found which has bright yellow bands on its abdomen and whose tongue is said to be longer than that of the northern form. This variety has been frequently imported into Britain, and among many beekeepers is regarded as the best variety for honey-storing purposes. In Carniola, again, there is a variety which has silvery bands upon it and is thickly clothed with silvery hair. This variety is exceedingly gentle, and it is also the most prolific, the queens requiring much more room in which to deposit their eggs.

The form found in Britain, and, indeed,

throughout the North of Europe generally, is of a dark-brown colour all over.

Although found wild in many parts of the Continent and even in Britain, it is improbable that such wild colonies are original descendants from wild bees, for bees have been kept under human ægis—one can hardly say "control"—from time immemorial. On the banks of the Nile there are cylindrical mud hives which no one knows the beginning of, while in Persia bees have been kept in the walls of houses so long that the memory of man runneth not to the contrary.

II

THE PERSONALITY OF THE HONEY-BEE

Although there are quite a number of insects which superficially resemble the bee, most people are able to recognise it when they meet it. The most individual characteristic is its method of flight, which is quite unlike that of any other insect.

Those who have studied insects closely can tell many species from each other more accurately by their flight than one can tell one's acquaintances by their gait. What practised butterfly-hunter does not know the noble sailing flight of the silver-washed fritillary, the beautiful evolutions of the White Admiral, or the short, jerky excursions of the common skippers ?

So, when we see a modest brown insect passing swiftly and systematically from flower to flower, its wings vibrating with incredible swiftness and with a hum that is, perhaps, one of the most joyful of all sounds to be heard on a hot summer's day, we know, without catching the creature and subjecting it to a microscopic examination, that

what we see is the most industrious of all living things, the honey-bee.

The anatomy of the bee has been often described, and I shall here give only a brief outline of its structure and the organs with which Nature has endowed it—organs which raise it very high in the scale of sentient creatures, and enable it to perform functions and construct works unlike those of any other creature.

Its head is somewhat wide, and on each side are the large compound eyes with which most perfect insects are provided, the antennæ, or feelers, which are usually regarded as tactile and auditory organs, sticking out just in front of them. A pair of strong jaws and a flattened tongue with a set of supplementary eyes called *ocelli* complete the chief organs of the head.

The thorax, or chest, is very strong and muscular, and supports the pointed wings and three pairs of legs. These legs are remarkable for the wonderful contrivances they are fitted with —contrivances without which the gathering of pollen, the manipulation of wax, and, indeed, the very habit of clustering, would be impossible. The first of these contrivances that deserves notice are the hooks with which each foot is provided and by means of which the insects are able to cling to each other. When comb-building is going on bees may be seen hanging in festoons by means of these hooks and manipulating the wax.

In each hind-leg is situated the curious contrivance known as the pollen-basket. It is a hollowed cavity surrounded by bristly hairs by means of which the grains, after being masticated with saliva, are retained in position during the homeward journey. The front legs have an auxiliary implement in the shape of a brush, by means of which the pollen is scraped from the flowers and transferred to the pollen-basket.

Within the large, roomy abdomen are contained the alimentary system, together with the honey-sac, in which nectar is carried home, the rudimentary sex organs, and the apparatus by which the sting which terminates the body of the insect is operated. Briefly, this well-provided creature is one of the most self-reliant of all living things, spending its days in ceaseless journeys into the fields in search of nectar and pollen, and its nights in house construction and decoration. Yet all this labour is performed for the sake of a generation which it had no part in the production of. There is, as it were, no mainspring of maternal instinct, such as is so plainly evidenced in most other living things. The worker bee, although possessing the degenerated organs of the female sex, has no power of using them, and is, to all intents and purposes, a sexless creature, an almost automatic portion of the hive machinery.

Clearly, this defect must be supplied in some way, or the race could not be carried on. The

fact is that there are in each hive three distinct kinds of bees, each performing different functions. The most numerous by far are the workers we have just described. The next in point of numbers are the drones. These are only to be found in the hive during the summer for a longer or shorter period, varying according to the season and other circumstances.

Ancient writers had the very vaguest notions as to what drones really were. That they were comparatively idle and useless had, indeed, been commented upon by writers from the very earliest days, but down to the middle of the eighteenth century the very strangest ideas prevailed about them. A very quaint writer, who seems to have found out for himself, with much diligence and patience, the true functions of the drone, tells us:

"There are none that have kept bees at all, but they know the Drone from the working Bees; but they are for the most part absolutely ignorant what these Drones are, or what Nature hath designed them for. I perceive the opinion that most prevails among the Country Bee Mistresses is, that they are Bees that have lost their Sting and so growing to that prodigious bigness (out of all proportion to the other Bees) they become Drones. Now this their mistake is occasioned by their seeing that they do no work, nor cannot sting, and so they give them that Contemptible Proverbial Name of a Drone."

All this ignorance has been cleared away, at least so far as the practical beekeeper is concerned, for there can no longer be the smallest doubt that the drones are males, and that their sole purpose in life is the propagation of the species. It may, perhaps, seem strange that there should ever have been any doubt about the matter at all; but the truth is that the love-making of bees is carried on quite differently to that of other creatures. Only those who have watched patiently and regularly have ever been able to observe even the preliminaries of it, and the actual accomplishment has seldom been witnessed. We may reserve till a later chapter the fascinating details of the bee's amours.

There are in each hive about two or three hundred drones during the summer months. They are readily known from the workers by their greater size, they being much more stoutly built as well as longer than the workers. The compound eyes are very much larger, meeting on the top of the head, and the antennæ have an extra joint, so that they are somewhat longer than those of workers. They are strong on the wing, but fly differently from workers, their deep booming note and very ostentatious and blustering manner making some amends to them for their real impotence, for they are quite destitute of stings.

The drone is, when it comes to the push, the

most helpless of all perfect creatures. He spends the greater part of his time battening on the stores gathered by his sisters and making himself a considerable nuisance by his dirty, indolent habits. He only ventures out about noon when the weather is perfect and bright skies and balmy air provide attractions.

But workers and drones would alike be useless for the purpose of maintaining the continuity of the race. There exists, therefore, one single, solitary, almost pathetic figure in every hive, a figure which stands to the colony as a representation of the very highest ideals, a life so precious that it never ventures out of the safety of the city, but is carefully guarded, tended, and fed all its days. This is what has been known for centuries as the Queen Bee, the sole and undisputed mother of the race. She it is who gives birth to all the teeming thousands that inhabit the hive during summer, who lives her whole existence in the dark interior, doing nothing from dusk to dawn and from dawn to dusk, but lay eggs in the countless cradles continually being prepared for their reception.

She is not greatly different in appearance from the worker bees. Indeed, until one is well accustomed to examining a hive, it is very difficult to detect her among the multitudes thronging the combs in the height of summer. Once recognised, however, there is no doubt of

her identity. In general build she resembles the worker, the first impression one gains on noticing her being that her wings are shorter. This is illusory, and is accounted for by the fact that her body and legs are longer than those of the worker. Later on I will describe in some detail the essential difference between the queen and the workers, but the photographs will give a good idea of her general appearance.

Thus we have the three essential constituents of the hive: the workers, to perform all the menial functions—the hewing of wood and drawing of water, as it were—the drones, idle and troublesome, but nevertheless essential to the race, and the queen, to perform the highest of all duties—to be the mother of her people.

III

THE ECONOMY OF THE HIVE

Much study has been devoted to bees from time immemorial by philosophers and others in order to find a model on which a human government could be founded. The idea is one which we do not intend, tempting as it must be admitted to be, to follow out.

The truth is, that from time to time almost all forms of government have been ascribed to the hive. It has been looked upon as despotic in its principles, all allegiance, all authority being vested in the queen, and, on the other hand, it has been argued that it is a perfect type of Socialistic brotherhood. All I intend doing is to state plainly what from experience and study are the ascertained facts relating to the regulation of affairs in the hive. Those who have a pet idea of what government should be, may try to fit it to the case presented to them, if they choose.

All insects pass through four distinct stages of existence. The definiteness of these stages varies considerably in the different orders, some showing the lines of demarcation only very slightly, while

others differ so completely in the successive periods that without complementary circumstances, it would be impossible to believe that the four different creatures were one and the same. These changes are known as the transformations or metamorphosis of insects, and in the bee they are as nearly complete as could well be imagined.

Since "all life from eggs" has taken its place as a more or less established dictum, we commence with the egg. There is no apparent difference between the eggs of workers, queens, or drones. In point of fact, the eggs are really the same in all cases, except that the worker and queen eggs are fertilised by a special process before being deposited in the cells prepared for them. More of this anon.

The egg being laid in a cell, there hatches from it a white grub, which grows rapidly under the influence of congenial temperature and nutritious food. At first, it lies at the bottom of the cell in the form of a crescent, when it is seen to be made up of several segments, stout in the middle and tapering towards each end of the body. Its diet is very special for the first day or so, but afterwards it is fed on rather coarser food, and gradually grows until, no longer able to lie curled up at the bottom of the cell, it stretches its head towards the mouth of it. When it has reached its full size, its supply of food is cut off and its

a *b* *c*

(*a*) DRONE. (*b*) QUEEN. (*c*) WORKER.

a

SHADING A NEWLY HIVED SWARM.
(*a*) Fanning to keep the hive cool.

AN OLD STYLE APIARY.

A MODERN APIARY.

cell sealed over by the workers. It then spins itself a fine silken shroud, and lies quiescent therein for a time, during which important changes take place. The simple grub-like form becomes a creature with a firm outer shell, provided with elaborate organs of flight, sight, scent, and taste, with powerful jaws, strong legs, and a deadly weapon of defence : in fact, one of the most self-reliant beings one could well imagine.

The change having been completed, this new being eats away the door of its cell and comes forth to take its place amongst the labourers in the hive. For the first week or so the young worker remains indoors, performing the duties of a nurse to the brood. Afterwards it takes its place, either in the entrance as a sentinel or ventilator, or out in the field foraging.

The old notion, and one which still lingers in many places, is that all the operations in the hive are performed at the behest of the queen. Nothing in modern investigations has tended to confirm this idea, at any rate, so far as any sentient purpose on her part is concerned. If intelligence is to be judged by the amount of brain, the queen is possessed of less than the workers. Moreover, there is no direct evidence that the queen ever interferes with anything that goes on in the hive. Her function is to lay eggs, and she lays eggs, strictly in proportion to the amount of food that is present or coming in at the moment. If stores

are scarce and bad weather prevents foragers bringing in more, egg laying is very slow, but the moment a change in conditions enables provender to be brought in, she commences to lay more freely.

Perhaps the strongest evidence against the idea of the queen being paramount as an authority is supplied by the strange events which take place when the colony has grown beyond the capacities of its dwelling and a new one is to be founded. When this is the case, the bees build some special queen cells and rear a number of young queens. Now it may be doubted whether the queen has any knowledge of what is being projected. Queen eggs do not differ in any way from worker eggs. The difference ultimately produced is brought about, strange though it may seem, solely by a different diet, and if we take a queen away from a hive which has not already commenced queen cells, leaving plenty of worker eggs therein, the bees will raise new queens from those eggs. Some observers even say that the queen does not lay the eggs in the queen cells, but that the workers remove them from worker cells and place them in the special cubicles that are being built for queen rearing.

At any rate, when the young queens come to maturity, which they do very quickly, the old queen manifests very great annoyance at their presence. She becomes aware of it by a curious

piping noise which the young princesses are able to make when they are ready to emerge, and she displays a most unmistakable desire to rush to the spot and slay her rival daughters. This she is prevented from doing by a guard of workers, who resolutely prevent her from approaching the queen cells. Ultimately she becomes so enraged that she leaves the hive, followed by the greater number of the old bees, who have already provided themselves with large stores of honey. The queen has nothing whatever to do with the choice of a new residence. This is sought for and decided upon by scouts, who go abroad for the purpose. Some say this is done after the swarm has left the old hive, but my own belief is that everything is cut and dried before the exodus takes place.

Under the question of swarming many interesting things may be discussed, but I will here content myself with saying that the devotion shown to the queen is really an instinct of self-preservation. The bees know well that without a queen their fate would be disastrous, and consequently they keep close to her and protect her carefully. But should she show signs of being injured or fail to produce sufficient eggs, they will without hesitation destroy her and provide themselves with another.

Perhaps, on the whole, the poetic Maeterlinck describes the authority as well as can be done under our present state of knowledge. He calls

the influence which spurs on the bees to their multifarious duties, "the spirit of the hive." Whether there is a committee which debates matters and decides important questions or not, is an interesting point which may perhaps be settled one day.

One thing is quite clear, and admits of not the least doubting. Nothing useless is tolerated in the hive. A bee which is injured and unable to perform its duties is removed from the hive, if indeed it does not take itself out of the way, which it usually does. Queen cells, when emptied and done with, are cut down and removed; old and failing queens are put to death and new ones raised. The drones, as soon as the honey flow is over, are likewise ruthlessly exterminated. They will only be tolerated so long as there is the means of replacing before winter comes the stores they consume so voraciously. Efficiency must be maintained at a high level, and no sacrifice seems too great to secure it.

Of course, the outstanding feature of the hive economy is the storage of honey in large quantities for future use. In England, and indeed in temperate countries generally, the flowers which produce honey, blossom over a very short period, and, therefore, if a colony is to be permanent, it must have collected during that period far more than it requires for its immediate needs.

This is why, in old-established colonies of bees, such enormous stores of honey are sometimes found. The stronger the colony, the more stores will it gather in the short period of the honeyflow. If the surplus over and above the twenty pounds or so required to keep the colony going through the winter is not removed, as it would be in the case of a domesticated hive, it accumulates year by year, until, in fact, the whole available space is full.

I have known cases where bees have ensconced themselves in various parts of a building—between the floor and the ceiling, or between the ceiling and the outer roof. I knew one old lath-and-plaster house where, during the summer, the walls hummed to such an extent that at last a bee-master was sent for. The outer plaster was removed, and the space between the inner and outer skins of the wall was full of comb in lengths of over six feet, and the honey weighed more than two hundredweight.

This honey-storing habit opens up one of the most interesting problems of evolution. We have seen that other species of bees, such as the bumble-bee, although they live socially, do not form permanent colonies. Their families are started by a female in the spring. This female was fertilised in the preceding autumn, and she starts right away to prepare a nest and bring in the food for the young grubs so soon as they commence to

hatch. As these come to maturity, they take their turn at building and foraging, until by the height of summer there are one or two hundred members of the colony. But the thing ends there. The sexes pair off, the males and workers (for there are workers among the bumble-bees) die, and each of the females hides away under moss in a state of torpor all the winter, becoming in her turn the foundress of a new colony.

The high state of specialisation found in the hive-bee is no doubt a complex mingling of cause and effect, and it would be very hard to say which is which. It would be impossible for a queen bee to found a colony, for she has not the means with which to build a single cell, to carry pollen, or even to procure the necessary food from the flowers with which to maintain herself. On the other hand, the workers have lost the power of reproduction, and are unable to propagate their kind.

The curious problem, and one which is not to be explained by any law that we are cognisant of, is that the workers, with all their wonderful cell-building, pollen-gathering, and honey-storing appliances and instincts, descend from parents who have never done anything of the kind, having neither the organs nor the requisite amount of intelligence. How is this complex instinct transmitted? It might be possible to

understand how, by the provision of special food, the ovaries of the embryo queen are developed, but it is quite another matter to understand how the withholding of such food can produce, for instance, the pollen basket of the worker, which both the queen and drone are destitute of. In a word, how are the working qualities of the neuters transmitted to an offspring they have no part in the production of ?

I confess I have never been able to satisfy myself on the subject, and I put it forward because, although several of my bee-keeping friends have discussed it by word of mouth, I have not been able to find any reference to it in the works of our great bee-masters.

IV

THE FOUNDATION OF A BEE COLONY

If I were asked what I consider the most distinctive characteristic of the hive-bee, I should say "the cluster." In some respects bees resemble other social insects very closely. They resemble the ant in the permanence of their colonies and in the division into three distinct types of inhabitant. In the building of combs they can be compared to the true wasps, but there is no other society which is so literally bound together as that of the hive-bee. The huge pear-shaped cluster which forms round the queen when the swarm settles after issuing from a hive is, for all practical purposes, maintained for ever afterwards, the only change taking place being the building of combs through it and its expansion or contraction according to the temperature and the amount of population. If we open an ant's nest, we find galleries running in all directions and ants at work in groups here and there. Not so with the honey-bee. There are never in the hive any outlying portions. However large the hive and however well provided with combs, the colony

always occupies one portion of it, usually the centre of the top. If we open a hive in the winter, we find the outer combs quite unoccupied by bees and usually empty, those on the outside being cleared first before the colony has dwindled in numbers. The feet of bees are provided with hooks, by which they attach themselves to each other, and it is really wonderful to think what an enormous weight the upper members of a clustering swarm must be supporting.

The natural method of increase of bee colonies has always been known as swarming. The word swarm is of old German origin, and is derived from the same root as swear. It really means a buzzing, and is doubtless accounted for by the great uproar which takes place when the bees issue from the old hive. Having been thus applied, the word has come now to mean in ordinary language, a crowd or multitude of people or things.

Swarming time is the most exciting period of the year, both for the bees and the bee-keeper. Many circumstances go to make it a very vital matter for the bees. So soon as the weather has become warm and settled, either about the end of May or the beginning of June, those colonies which have become too large for their quarters set about preparations for founding a new one. It is singular that this is almost an isolated instance in Nature, if indeed it is not the only one, of the old members founding the new home

and leaving the younger generation in possession of the old.

The very first step taken when a colony projects such an irruption is the laying by the queen of drone eggs. These drone eggs are laid in specially large cells. As soon as the drones are ready to emerge, the workers commence to build special cells in which to rear a number of young queens, one of which is to become the ultimate mother of the hive. It may sometimes happen, after this work has commenced, that a change in the weather, bringing a succession of wet days, when stores cease coming in and outdoor work is an impossibility, compels the colony to change its mind and give up all idea of swarming.

In such a case the embryo queens will be dragged out of their cells and the cells themselves pulled to pieces. Another change in the weather, with a consequent further overcrowding, may necessitate the operation being gone over again. In a fitful, changeable season this may happen two or three times, and ultimately the swarm may never take place at all.

Assuming everything is favourable, however, there comes a time when the oldest of the young queens, having arrived at maturity, begins to gnaw at the door of her cell and to give out her shrill, piping note. This sound has a most disturbing effect on the old queen. Her instinct is to brook no rival, and she attempts to approach

the royal cell with the object of destroying the young virgin. Being prevented by the workers from doing this, she at last rushes out of the hive, and all the older members of the population go with her. The scene on such an occasion as this is one of the most exciting that can be imagined. If one is watching a hive that is expected to swarm, say about noon on a fine warm day, there will not appear to be anything very unusual going on. In fact, the hive generally appears rather quieter than usual, on account of the fact that, in anticipation of the event, the larger number of foragers, instead of speeding their way to the fields in great haste, are lounging round and filling themselves with honey. If the hive is very populous indeed and the weather hot, large clusters of bees will often be found hanging round outside. A few younger bees go off from time to time to seek for honey. A few others are coming back laden, but on the whole the hive presents an exceedingly indolent appearance.

All at once, however, the scene changes. A loud buzzing is heard in the hive, and the bees begin to pour out as fast as they can burst through the entrance. In a few moments the air is filled with a flying, tumultuous crowd, and the sound of thousands of vibrant wings raises the onlooker to a pitch of excitement hardly exceeded by that of the bees themselves.

After a few moments of this stirring commotion, the cloud is seen to approach a tree or, if there be not one handy, a bush, or post, and gradually it will be seen to be getting smaller and smaller as the flying squadrons converge to a given spot. On this spot the queen, who has perhaps not been on the wing for years, has elected to rest for a time, and gradually the whole mass of bees shrinks into a compact, pear-shaped cluster. After a time all is still, and the swarm might rest there hours without any one being aware of its position. At this juncture the bee-keeper usually steps in. Providing himself with a straw skep or box, he holds it beneath the cluster, and, violently shaking the bough, precipitates the bees into the receptacle. If he has succeeded in shaking in the queen, all the other bees will follow, and in a few minutes the whole swarm will be quiet in the skep. Should the queen still be on the bough, those shaken into the box will leave it and return to the queen. If by any chance during these manipulations the queen should be lost or killed, the bees, after searching for a time round the bough, will return to the old hive.

Supposing, however, that the bee-keeper does not capture the swarm after it has settled, it will remain there for a time, longer or shorter, according to circumstances. I have known one stay only half an hour, and on another occasion one remained all night and built a comb on the bough. It

chanced to rain heavily some time after they had settled, and therefore they dared not make a long journey.

Sooner or later, however, the swarm will move off to its permanent location. Some writers say that it is not till the swarm has settled for this first time that the scouts go out to find a new home. I do not think this is the case. The risks of remaining in the open until such time as a suitable location is found seem to me too great, and one instance I will mention which came under my own observation will, I think, confirm my belief that the home is found before the swarm leaves the old one.

One day in early June a stranger called upon me to ask if I would hive a swarm for him, having heard I was an enthusiastic bee-keeper.

I happened to be extremely busy, but, not being willing to appear disobliging, I went with him a distance of about half a mile. I found the swarm clustered round a pear-tree in a situation where it was impossible to shake them off. I therefore suggested supporting the skep on two poles over the cluster and driving them up with smoke. Some time elapsed before we found suitable poles, and by the time I had them erected I was obliged to leave, so I showed the owner how to smoke the bees so as to get them in, and told him I would return in about half an hour, hoping by that time to find he had secured them. When

I got back to the place, however, I found that he had not succeeded in getting all the bees in, and, not daring to lift the skep down to see if the queen was in, no great progress had been made. I had only just taken the smoker from him with the idea of driving them in more quickly, when the swarm began to rise, and in a few moments was in the air. I tried by squirting water on them to induce them to settle again, but it was of no avail, so the only thing I could do was to follow them. They went slowly at first, but kept in a perfectly straight line, and after a time increased the pace, so that I had much ado to keep them in sight. Altogether they went about half a mile, and when I actually came up with them, they were hiving themselves in an empty hive fitted with combs in a garden.

Now, I think it would have been a most extraordinary coincidence if they had happened to have discovered this very suitable hive, such a long distance away, in the very short time following their issue from the hive. I remember another case which was related to me of a swarm which had only been on its bough a few moments when the bee-keeper captured it and placed it in a bar-frame hive. He had no sooner hived it, however, than the swarm flew out and made straight for a hole in a tree in his garden. He had to procure a ladder to get them, and by the time he had done that they were safely

ensconced inside. It seems to me most unlikely they would have left a properly prepared hive unless they had already made up their minds where they were going. In this case they certainly appeared to have been pretty positive about it, for it does not often happen that, having been provided with a comfortable location, they will desert it. The queen is no doubt only too thankful to be saved such a troublesome journey as it must be to her.

The manner in which a swarm enters its new hive is in marked contrast to the style of leaving the old one. The helter-skelter excitement is changed to a most decorous and orderly procession. Bee follows bee steadily into the hive and mounts to the roof, in the centre of which the first-comers affix themselves, the others hooking on to them until all are safely in. After a brief rest, comb-building commences. This fascinating operation must be described in a separate chapter.

V

THE BUILDING OF THE CITY

Insect architecture is a theme upon which volumes could be written, and a lifetime might be spent in the study of it without fathoming a fraction of its mysteries.

Around this particular phase of the wonders of nature, controversy has raged more fiercely perhaps than any other, for in it the theologian of the old school and the naturalist contemporaneous with him, saw indisputable evidence of the marvellous Guiding Hand. How, they asked, could such things be explained on any other hypothesis than direct teaching from God himself?

It always seems to me, and it may have occurred to others in the same way, that if God taught these insects exactly what to do in the direct and personal manner these warriors stood up for, why are not their results absolutely perfect? We look at the beautiful combs of the bee and think them perfection, but, if critically examined, we find it possible for improvements to be made on them. For instance, I have often thought what a convenience it would be if the brood cells were

A HIVE READY TO SWARM.

SWARM ON A ROSE-BUSH.

provided with a hinged lid, which could be lifted up for the egg to be laid in and shut down when the grub was full grown. Instead of that, these lids have to be made fresh over and over again during a single season. The bee-keeper may smile, but it would not be any more wonderful than the lid of the trap-door spider, nor anything like so remarkable as the wonderful shape of the cells in a honeycomb.

Although this insect building is found amongst all orders, from the queer caddis grub, which builds itself a case of leaves, stones, or any other material that comes handy, to the moths and butterflies, who build themselves wonderful tombs in which to change from grovelling worms to winged spirits of air, yet the Hymenoptera is *par excellence* the order in which this building reaches a high state of perfection. The subterranean cities of the ants have been the wonder-exciting subject of all times, but the structures of the bee and the wasp stand pre-eminent for their unique design and for the outstanding feature of a special material being manufactured to build them of.

There are fundamental differences between the combs of wasps and bees, analogous though the two structures are. In the first place, wasps' combs are made from wood pulp, chewed from old posts and masticated until they form a tough paper-like material. In the case of the bee, the material is evolved from its own body, the " wax "

being a kind of fatty exudation taking place in special organs. Then the combs of the bee are hung perpendicularly, the entrances to the cells being from the side. They are, moreover, so arranged as to effect a very great economy of space, being double, so that the base of one cell lies at the point where the three sides of the opposite cells meet. Wasps' combs, although made of hexagonal cells, are built horizontally, and the entrance is underneath, the top being quite flat and forming a platform upon which pillars of wood-pulp are reared to support another row of cells built in like manner.

It is, I think, generally conceded that the bee has made the farthest advance. There would appear to be very little room for improvement in the direction of economy, the structure of the comb having been admitted by mathematicians to be the most perfect that could be devised to secure strength with economy of space and material. Any other form would involve either more space, more material, or a weakening of the structure.

In the last chapter we left the swarm hanging to the roof of its new domicile. Having satisfied themselves that the roof is quite firm, the bees commence operations. Although I shall describe in succession several proceedings, it must be understood that many of them take place at the same time, the work being divided up amongst

all the members of the colony, and thus proceeding at a great rate.

As soon as the wax, which has been accumulating in the wax pockets on the underside of the bee's body, is ready, which is only after the bees have been in the hive long enough to raise the temperature to at least 80 degrees, the first bee leaves the cluster, and, after kneading the wax well with saliva, she sticks it to the roof, adding layer after layer till all her wax has gone. Others come in succession and add wax, until a block of some size is formed. Bees then scoop out circular hollows in this block, piling the wax removed from the hollow, round the edges.

Much discussion has raged about this subject, some maintaining that the insects build hexagonally, others asserting that the hexagonal form only comes after a number of cells are built and is indeed an inevitable result of the bees' method of working. My observations incline me to support the latter view. One experiment I made, and which I am enabled to reproduce in the form of a photograph, shows clearly that the beginning of the cells is a circular hollow. I gave a small swarm of bees a block of very rough, uneven wax, in the form of a sheet about six inches deep and eight wide, the thickness varying from one-eighth to nearly a half-inch. In this wax holes were scooped at irregular intervals and the wax piled up as before described. It was not until

a very large area had been thus worked upon that the cells began to assume the hexagonal form. The fact is that there is a certain thickness, or rather, thinness, beyond which the bees will not go. As soon as they reach a point when, working as they do from opposite sides at the same time, the slightest further amount of work would break through the partition, they stop. It seems clear to me that, starting with circular cells, and working in this manner, the hexagonal form is inevitable. The hexagonal shape makes it necessary that the cells of one row should be situated not exactly under those above, but in the intervals between them. This result corresponds with what one would naturally expect when the bees are working together as closely as is the case, for the most economical method of working is the *quincunx* system, which is precisely the same as the disposition of the cells.

Very much has been said about the perfection and beauty of the combs, and I yield to no one in my admiration of the excellent work, but it is quite overdoing it to say they are always mathematically exact in size and shape. Quite apart from what are known as " transition " cells, which occur when a change is made from constructing worker cells, in order to begin building the larger drone cells and also the queer-shaped cells which occur at the points of attachment and in odd corners where it would be impossible to fill the

space properly with regulation cells, there is, when one comes to examine them closely, a considerable amount of irregularity both in the shape and size of the cells. I have a beautiful piece of natural comb before me as I write, and in one row of cells, quite in the middle of the comb and therefore not to be accounted for by unusual conditions, there are no two cells exactly alike, even to the eye.

Then again, it has been said that the base of one cell is always exactly at the point where the three cells on the opposite side meet, whereas there is a very considerable variation, the meeting-point being sometimes quite close to the side of the cell. One can only conclude that those who were responsible for these observations had never examined a comb—I speak now of a natural comb, for of course, with comb built from artificial foundation, where the cell bases are stamped out by machinery, there is no room for divergence. To my mind, the wonder is, seeing the irregular way in which the bees commence cutting the pits, that they approximate to accuracy so closely as they do.

As soon as the first comb is well started, another is commenced exactly parallel to it, and at such a distance that, when the cells are completed, there will be just room for two bees to pass between the combs. This is, to my mind, more remarkable than any other feature of comb construc-

tion, for when the block of wax is first put down, there is nothing to guide the bees as to the distance at which to put the block for the second comb. They must allow for the lengths of the cells, in which one can only suppose memory assists them.

Here, again, there is not absolute perfection, for naturally built combs are frequently very irregular, and if they have been in a hive the whole of a good season, they will be found to vary in thickness. This is because, having been built crookedly at the start, some cells have had to be made much deeper in order to fill up the space. When honey is coming in too fast for fresh cells to be built to receive it, the cells along the top are frequently built out till only one bee can pass between the two combs. The depth of the cells of both drones and workers is a trifle under half an inch, but in the case of drone cells, the cappings which are put on after the grub has grown to its full size are very convex, so as to allow room for the extra length of the creature. Although this is the normal depth of a cell, when honey comes in plentifully, cells are lengthened wherever possible, and I have seen them only a little short of two inches deep.

One of bees' characteristics, that, in fact, upon which the whole science of modern apiculture depends, is that they will always enlarge existing work rather than undertake entirely new. Thus, if, instead of being allowed to build combs

in their own way, as our forefathers allowed them, they are provided with sheets of wax, as modern bee-keepers do, they convert this into comb. This wax being originally put into a frame just the right size to fit the hive, and a number of these frames being put in to hang so that each sheet of wax is parallel with the others at exactly the right distance apart, the bees are induced to build combs that can be removed at will.

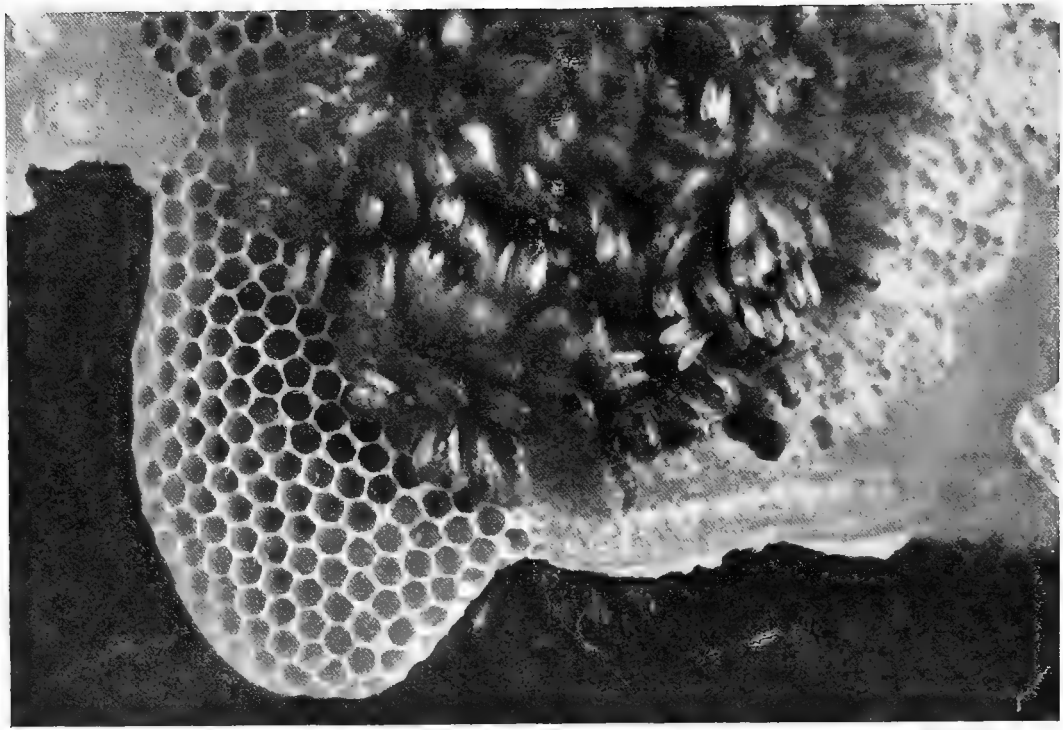
While the comb building is going on in the new hive, other bees are at work to make the room in which they are to spend the rest of their days a sound and secure habitation. This they do by filling in all crevices and loose places with what is known as "propolis," and consists of the gum gathered from buds of chestnut, sycamore, and similar trees.

As the construction of comb advances, each cell is put to its appropriate use immediately. Those at the top, which are usually of irregular shape and unsuitable for brood-rearing purposes, are filled with honey, which is, at this time of the year, pouring in very fast. Lower down, cells of the right size to contain worker grubs are being visited by the queen, and before the combs are finished a large part of the space is occupied by eggs and young grubs.

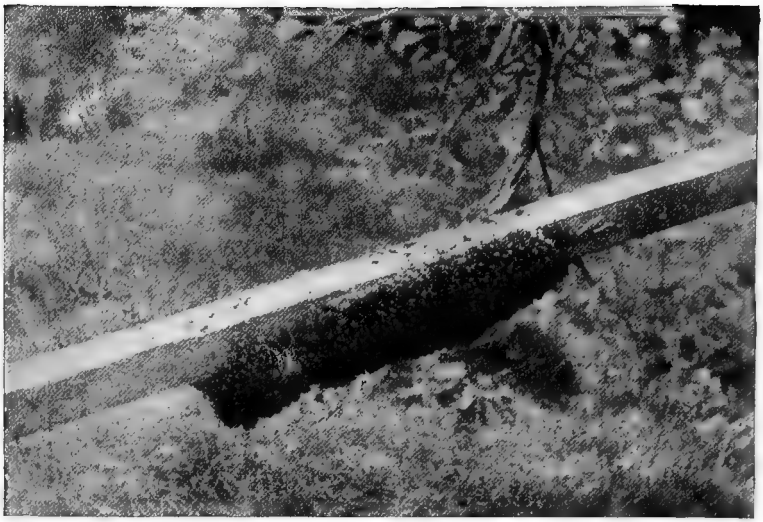
The rate at which the work proceeds varies according to the season. A May or June swarm, given fine weather and a good honeyflow, will

complete its combs in a week or so, while, if the swarm is a late one and the weather cold and wet, it may take several weeks, and sometimes work is by no means completed when winter comes. Such a calamity is usually fatal to the colony, for, not only are there very few young bees to live through the winter, but the shortage of stores makes starvation the almost certain end. A weak colony consumes, proportionately, much more food in the winter than a strong one, on account of the difficulty of maintaining a proper rate of temperature.

As soon as things have progressed sufficiently to make it worth while, a guard is posted at the entrance to keep out marauders, and the regular routine work goes on as it did in the old hive. Something concerning this routine we leave for another chapter.



CONVERTING A SHEET OF WAX INTO HONEYCOMB.



A SWARM ON A RAIL.

HOW IT WAS HIVED.

VI

THE HONEYFLOW

The time when swarms issue and found new colonies is the busiest of the year. About the end of May or beginning of June the white, or Dutch, clover comes into bloom. It may be a surprise to many people to know that this insignificant flower is, in England at least, by far and away the greatest source of honey production. The gorgeous flowers of roses and lilies, and, indeed, the greater portion of our familiar garden flowers, are practically valueless so far as the bee is concerned. A single head of white clover is worth more than half a dozen rose bushes, and the most gorgeous clematis is a hollow sham compared to the modest flowers of the lime tree.

So soon as the little white specks of clover begin to become noticeable in the meadows and hedgerows, for, fortunately, the tiny trefoil is a hardy grower which thrives under all sorts of conditions, work is the only thing life holds for the inhabitants of the hive. Rise when you will, in the small hours of a June morning, you will hear the steady

hum in the hives which tells of ceaseless toil. In the grey dawn bees fret at the entrance, running in and out, all eager to get away to the fields the moment there is light enough to steer a course by. By the time the sun has sent his first rays of golden light through the tree tops, the army of foragers has begun to move. A few hardy spirits lead the van and others follow, the numbers increasing steadily, until, by the time the majority of folks are coming down to breakfast, a steady stream of brown atoms is pouring out of the hive at breakneck speed. Some shoot out of the entrance, flinging themselves headlong into the air without a pause. Others run a little way down the alighting board and launch off like a practised and fearless diver taking to the water. None hang round the hive, but fly straight off to the spot which is at the moment yielding the greatest profusion of nectar. By the time the sun is well above the horizon the bees who went out first are beginning to return, their bodies swollen and shiny, their hind-legs in many cases holding great masses of pollen, or "bee bread," as bee-keepers call it, vital nitrogen for hungry baby bees. Weighted to the utmost of their capacity, they alight as near the entrance as possible and crawl heavily in.

As the sun climbs higher, the hive grows warm and oppressive, and if we stand near it, we hear a new sound proceeding from it, a steady "Zer

zoom ! zer zoom ! zer ! zer ! zoom ! " like a miniature thrashing-machine in full work. Looking in at the entrance, we see a row of bees standing in a line, facing inwards, their feet firmly planted, heads down and tails erect, their wings vibrating with incredible swiftness. These are the " fanners," or ventilating bees, forcing air in to cool the heated interior. Their numbers are increased or diminished according to the temperature, until, sometimes, they almost block the entrance, making it difficult for the now fast-returning foragers to get inside. Bees emerging in haste to rush to the fields cannon against them ; returning bees alight sometimes on their very backs, but still they keep steadily on with their humble duty, until such time as declining day renders their task no longer necessary.

About midday, from old-established colonies, there come forth the great hulking drones. These show no eager, violent haste to rush away to the fields. They emerge leisurely, survey the prospect, and carefully smarten themselves up. When their toilet is completed to their satisfaction, they fly off with a deep booming sound, trying, as it were, to impress all and sundry with their magnificence. From first to last their life is one of luxury and self-indulgence. They do not forage for themselves, but batten most part of the time on the ready prepared stores their sisters have slaved to procure. They are dirty and

indolent, and, for the brief space of their existence, carry things with a high hand.

While this ceaseless stream of labourers is coming and going, the inside of the hive presents no less animated a scene. On a centre comb the queen mother is moving from one cell to another with studied order, surrounded by a crowd of attendants, who ply her steadily with nourishment. First poking her head into a cell, to see, so it is said, that it is quite clean, but most probably to make sure there is not already an egg there, she next inserts her abdomen and deposits at the bottom the little pearly white egg. Without pause she goes on to the next, in gradually widening circles. In the course of twenty-four hours she lays somewhere between two and three thousand eggs. On the next comb, which she was working upon three days ago, the tiny grubs are hatching, and are being attended by the nurse bees. These nurses are the younger bees, little fledglings which have only emerged from the cells a day or so. They are feeding the young larvæ with a mixture of honey and pollen, half digested by themselves, and mixed, it is believed, with a kind of milk, which, normally, is only secreted by the very young bees.

Further back are cells containing larvæ nearly fullgrown, which are being fed with coarser food more suited to their stature. Beyond these are cells covered in with a dull yellowish layer of wax

and pollen. These contain grubs which have finished feeding and are now enjoying a period of quiescence in their tomb before coming out to join in the never-ending round of toil. Near them are other cells, in which crescent-shaped cracks are appearing and enlarging, until young bees come forth, fluffy, downy creatures, as yet all unfitted to do any hard work. No sooner do they emerge than another bee enters the cell and carefully cleans it out ready for the next visit of the queen. Here are cells being filled with pollen of all shades, green, yellow, grey, or brown, while here and there we see an open pool of glistening honey, all ready to hand for the feeding of the babes. Higher up, in the surplus chambers, there is nothing but honey. Bees returning laden with it, climb to this upper storey and there discharge their loads of concentrated sweetness. All these combs are new and of a glistening whiteness. For the most part, the contents are a rich golden colour, though here and there a special portion is set aside for the darker honey from the limes or blackberries.

Lines of bees are hard at work, lengthening the cells to their utmost capacity, or making the waxen coverings to seal it safely up against the approach of winter. Others are busy filling up cracks and crevices in the walls, or removing the bodies of deceased comrades, for in such a vast population engaged in such ceaseless toil, the mor-

tality, though not excessive, is still pretty considerable.

So the work goes on from dawn to dusk and from dusk to dawn, for day and night do not count inside the hive, where it is, be it remembered, perpetually dark. All this wonderful organisation is carried out without assistance from the organs of sight.

It would be hard to say what the special sense is that enables everything to be done with such accuracy. Many think that the antennæ with which all insects are provided is the seat of a sense of which we can form no conception. Whether this be so or not, it must be clear to all who have studied bees closely that these organs are extremely useful. The bees take great pains to keep them clean. Upon issuing from the hive, each will be seen to pass the antennæ through the forefoot, the special comb-like arrangement situated there being used to remove any adherent particles which may clog the delicate nerve-served hollows situated upon them. That they serve as organs of touch there can be no doubt. The very name "feelers," popularly applied to them, is well warranted by observation. But that this ends the usefulness of the organs cannot for one moment be believed, when we consider the marvellous elaboration of them which is present in many insects.

One outstanding and significant feature is the fact that in male insects they very frequently

have a higher degree of development than in their partners. That this is so with many of the butterflies and moths is very well known. It is also well known that some of the kinds which boast an exceptional development of antennæ, have a remarkable power of finding their mates. Such examples as the Emperor and the Fox Moth are familiar to all insect hunters. But whether the action of the organs is by way of hearing or scent has not been definitely discovered. Judging from the moths, hearing seems unlikely, for these insects, with one or two exceptions, make no sounds that we are aware of, although it is possible that they may produce some that our ears are not able to respond to. Bees, on the other hand, undoubtedly do make sounds. There is the curious piping of the young queen already referred to, and the workers make a most variable range of sounds with their wings, sounds which mean something, even to the bee-keeper, who is well able to distinguish between the joyful sound made when swarming and the angry buzzing of a truculent hive.

It may be, therefore, that the antennæ serve the purpose of hearing, and thus enable bees to communicate with each other in a more or less perfect manner. At all events, as in the other insects, there is a greater development of the antennæ in the males, although it does not extend any further than the possession of an extra

joint, the drones having thirteen segments against the workers' twelve.

There is a wide field for research open in connection with the subject, our knowledge of it being aptly described as paltry.

I have spoken of the honeyflow as though it were one definite period. That is how it is usually understood among bee-keepers generally, but, as a matter of fact, it is sometimes a very protracted and intermittent period. For instance, there is usually a strong flow of honey in the spring at the time cherries bloom. It does not last very long, and if it occurs very early, the bees are not strong enough in numbers to take full advantage of it.

There is then usually a gap of a week, during which, by very hard work, even if the weather is favourable, the bees are not able to gather more than sufficient for daily needs. Then the apple trees commence, and yield plenty of honey. If the weather is fine, a careful bee-keeper may succeed in getting surplus for his own use from apple trees. After the apple comes the hawthorn. This is a most singular flower from the point of view of honey production. Sometimes it appears not to provide any at all. I remember in 1910 the hawthorn was very abundant in my neighbourhood. We have a large number of fine old trees, which were a mass of snow during that May, but I never saw a bee at it the whole time it was out.

The following year it did not bloom so freely, but the bees simply crowded to it, and I took from one very forward colony twenty pounds of pure hawthorn honey.

Seasons vary very greatly, but usually there is a gap of a fortnight after the hawthorn finishes before honey begins to be stored in any quantity. About the end of May or beginning of June the white clover commences, and if favourable conditions prevail, very large stores of nectar are brought in from it. It lasts longer than any other crop, sometimes, indeed, flowering twice, but for two or three weeks the quantity of honey brought in is simply astonishing to the uninitiated. In a very good district, where the hives are right in the middle of clover fields, it is not uncommon for a colony to store ten pounds a day over and above its requirements. And this for several days in succession. As much as three hundred pounds of honey have been stored by a single colony in little over a month in a good season, while it is considered nothing out of the ordinary to take a hundredweight from colonies in good clover districts.

Perhaps there is no flower which the bees really like so much as that of the lime tree. In my district, when the limes blossom, the bees usually desert everything else, and in our churchyard, where there are several grand old trees, the noise of bees humming there on a fine July morning is some-

thing to be dreamed about. The honey from limes is not very well appreciated by the general public, which is attracted by colour, preferring, as a rule, the light golden honey from clover bloom, but to those who are connoisseurs, the dark greenish product of the lime trees is most delicious.

In the North of England and Scotland the heather is a great source of honey production. It will yield nectar sometimes for nearly six weeks in great abundance, but as it does not commence blooming till August, and sometimes nearly the end, the weather is very uncertain. Often it is so cold that the bees are unable to build comb, so that those who make a speciality of getting heather honey, usually provide sections which have been partly built during the clover honeyflow, or else shallow combs which have had the honey extracted from them. Heather honey is different from all others, in that it is very thick and dense. Fresh honey from other sources will run as soon as a comb is cut into, but heather honey will not do so. The apparatus by which honey is thrown out of the comb by centrifugal force, leaving them uninjured and useful for another season, is no use at all with heather combs, which have to be squeezed by the old-fashioned method to get the honey out.

VII

GUARDING THE TREASURE

No one who has kept bees can fail to know when the honeyflow is over for the season. To the beginner, who knows little about the whys and wherefores of bee ways, it may appear strange that all at once, instead of flying out in countless numbers to the fields, the greater part of the hive population remains at home, hanging about the entrance and adopting a truculent attitude to every one who approaches.

The tall hollyhocks are in full bloom and the garden is gay with all kinds of flowers. Bumble-bees appear in great numbers, and seem as busy as ever, but the honey-bee does little or nothing. Here and there one may be found in company with its great black-and-white cousin, rifling the contents of the stately hollyhock or humming merrily round the bed of clarkia or mignonette, but the open field knows them no more. Round the hive entrance they may be seen in great numbers, the alighting board being covered with a mass of them, wandering aimlessly round and pouncing on every insect that attempts to enter.

It must be very trying for the proper inhabitants of the hive, who are still doing their best to add to the great mountain of stores, to be challenged by several bees each time they come in, but the colony will take no risks. When there was no difficulty in getting honey, they did not bother very much about a stray pilferer or two, but now any unauthorised person is promptly warned off.

If the weather is hot, a huge cluster will come and hang outside a populous hive, for the temperature is very high in the limited airspace now left within. The fanners still keep blowing for all they are worth, but they are doubtless grateful when night comes and they can get a little rest. A few bees prowl round in search of sweets, and if there should be a jam factory or sweet-shop handy, a raid will sometimes be made if a colony has still plenty of storage room.

These robber bees are a very great nuisance. If they once contract the habit, nothing seems to cure them. They will search out weak, badly defended colonies, and endeavour to carry away their stores, and as bees never permit this to occur without fighting for their precious treasure, there are apt to be the most sanguinary battles. The wise bee-keeper will see that the entrance to the hive, especially of a weak colony, is narrowed down until only one or two bees can pass at a time, for if fighting once commences, it is very difficult to stop. Round the entrance to a hive which is

being attacked there is a terrific uproar. Bees dash about in all directions. If allowed to go on, the whole apiary will soon be in a perfect turmoil. The dead fall by hundreds, and woe betide any bee-master who dares to go amongst the struggling aerial armies unprotected. The only way to subdue them is to take a garden syringe and persistently pour water upon the combatants. I have had a good half-hour's work with this implement before I could reduce things to anything like quietude.

Nor are robber bees the only enemies which give trouble at this time. Wasps have become very numerous, and are formidable opponents. Usually they attack only singly, hanging slyly about the entrance in the cool of the evening, and seizing an opportunity to dodge the sentries and get inside and out again before they are discovered. Wasps have a great advantage over bees in that they are much more agile on the wing. Their prey consists to a large extent of flies, which they have to catch in order to feed their grubs, and consequently they can dart here and there with surprising agility. Moreover, they have no difficulty, when they sting, in getting the barb out and using it again, whereas a bee can seldom succeed in doing so, but generally leaves it behind, rupturing the abdomen in the process, and dying a lingering death in consequence. Notwithstanding these drawbacks, a bee will unhesitatingly hurl

itself upon a wasp that it sees attempting to enter. Clasped in each other's clinging feet, they roll over and over on the ground, until usually the wasp succeeds in stinging its adversary and flies round for another attempt. I have seen hero after hero perish in this manner from the attack of one wasp, until at last, the wasp, having used up all its poison for the time, either retires vanquished or is overcome and slaughtered.

Strangely enough, these combats are usually single-handed. If two or more were to attack the wasp at once, it would probably stand a poor chance, but all the other sentries appear to take not the least notice of the fray, and simply await the issue. If the bee returns triumphant, it is doubtless honoured accordingly. If the wasp appears again, another sentry is detached to tackle him.

If a hive is weak and several wasps succeed in getting honey from it, they will bring others to the feast, until, if precautions are not taken, the whole colony will be slaughtered and their stores carried away.

As soon as a change occurs in the weather which indicates that winter is approaching, the nights becoming colder and inroads on the stores having to be commenced, another form of conflict commences, this time of a very one-sided nature.

The great hulking drones, who have, until now, lived on the fat of the land and enjoyed life to

its utmost, are no longer to be tolerated. So long as plenty of stores were coming in, and there was some possibility of their being required in case the issue of a late swarm should render it necessary for a young queen to be mated, their presence was tolerated, but now the fiat goes forth and their expulsion is ordered.

It is usually in the evening time that this orgie takes place. If one listens close to a hive, one will hear a fresh sound at intervals, something like "B'rr!—b'rr!" Almost immediately after, a drone will be seen being pushed out of the hive. Others follow in rapid succession, until there is a crowd of them round trying to force their way in again. It is really comical to watch this spectacle. "B'rr!" we hear, and a drone appears with a worker on each side of him, dragging him by the wings or legs unmercifully to the edge of the alighting board and dropping him over. Again one will appear with only a single worker tugging the huge unwieldy form along, regardless of his struggles.

When all are pushed out, a long line of workers ranges itself in the doorway and resolutely refuses to allow a drone to enter. As fast as they come buzzing up to the entrance they are pushed back again, until, grown weak with this unusual exertion, they fall to the ground, or remain clinging to the sides of the hive. As the chilly night descends upon them, they sink into a torpor,

from which they do not awake. This is an opportunity for the prowling toad. It is usual for one or two of these gentlemen to keep about the neighbourhood of a hive, on the chance of picking up stray bees. Frequently one ensconces himself the whole summer under the floorboard of a hive. He does not get much in the daytime, but at night he comes out and picks up the stray bees, some of which are always to be found round about the hive in the evening—mostly exhausted foragers who have sunk under their last heavy load—but the honeyflow does not provide him with such a feast as these castaway drones.

It occasionally happens that drones are allowed to live all through the winter. This is no mere freak of a colony, for in every such case it will be found, either that the queen has died, or that she is so weak and failing that there is a possibility of drones being required to fertilise a new mother. Only under such circumstances are drones ever permitted to live after the cold weather begins.

VIII

WINTER

SUMMER has departed, and the calm of autumn rests on all things. Every creature who is to live through the winter must by now have accumulated a store of food. Those colonies of bees which have been unable (either on account of being late swarms, or because the season has been a lean one) to provide ample stores will, as surely as February comes round, starve to death. Nor is this the only peril that menaces weak colonies of bees. In some cases the queen is not able to keep the egg-laying going sufficiently late to provide plenty of young bees to live over the winter. Such will often dwindle away in the first days of the next spring, the old bees being unable to stand more buffeting with cold winds. Sometimes, also, the honey harvest has been so abundant that there is no room left in the hive for the queen to lay in, and in such cases as these colonies at times die out in the early spring.

In any case, every possible thing is done to make the home secure against the rigours of winter. The chilly nights begin to indicate

where draughts enter the hive or heat escapes, therefore on every favourable opportunity bees go forth to collect propolis with which to stop up these cracks. In districts where trees such as the horsechestnut abound the bees use an enormous lot of this gummy substance. In my hives it is used to such an extent as to be a perfect nuisance, combs and sections alike being glued fast down to the hive body, so that a chisel has to be used to remove them.

By the end of October all work is over for the season. The last few batches of eggs have been laid, and henceforth for the most part the colony lives in a semi-torpid state for the whole of the winter. They are not, however, as many people may imagine, entirely quiescent. If they hibernated perfectly, like the dormouse or their cousins, the bumble-bees and wasps, there would be no use in storing up such a vast quantity of food, for a colony consumes during the winter very nearly twenty pounds of food. Whenever the outside temperature is about 45 to 50 in the shade, the bees begin to move about freely. The cluster, which during the preceding cold or wet days has been lying packed together closely, spreads itself out over the hive. The bodies of those who have died are dragged outside and the place cleaned up.

About the middle of the day, even in midwinter, should the thermometer go above 50, large

numbers of bees come out of the hive and fly round for an airing. They never go far away, but keep in a little cloud just over the hives or before the entrance.

These "cleansing flights," as bee-keepers call them, are very necessary for the bees' health. Honey is a very pure food, and there is comparatively little waste with it. Bees are very cleanly insects, and never, when they are in health, soil the insides of the hives with excreta, and if they are confined for any time by bad weather, there is a considerable accumulation of waste matter in their bodies. Hence this opportunity is taken to cleanse their organs. When bees are artificially fed, as is necessary when the larger portion of their stores is taken from them, it is very important that only the purest cane sugar is used, otherwise the waste matter will give the bees dysentery, resulting in soiling of the hives and the death of a large number.

Even in the consumption of their stores, the insects are very orderly. The outside combs are commenced first, the food from them being passed across to the centre. As the colony grows smaller, so the outside combs become empty, until by the end of the year the whole colony occupies a spherical position in the middle of the hive.

In the depth of winter, when the snow is on the ground, bees are perhaps as safe from the dangers

of life as anything could well be. It seems to matter little how low the temperature goes, nor how much it snows. An old bee-keeping friend of mine told me that in the severe winter of 1881 he had hives buried completely in the snow. In one case the roof had blown off and the snow was falling between the frames. Yet they suffered no harm, and came out strong colonies in the spring.

One enemy is very active at this time. The Blue Tit and the Great Tit are very fond of bees, when they can get them, and they are cunning enough to tap at the entrance to a hive until a bee comes out to see what is the matter, when it is promptly despatched.

Of course, all this procedure is only approximate. In very long severe winters, bees, providing they are strong in numbers, winter better and on less stores than when the weather is open and mild. In mild damp winters there is a strong tendency to dysenteric conditions, consequent on the greater activity which prevails. They also require much more food to last them through a mild winter. Weak colonies winter badly, unless they are in a very small space and have abundance of good food. They eat more in proportion than strong colonies.

In mild winters it is no unusual thing for breeding to commence very early in the new year on a small scale. Some writers think it only

commences when stores begin to come in, but I am sure this is not entirely so, for in the first days of the new year, however mild it may be, there is nothing from which honey could be procured. The very first thing to start the bees into activity are the snowdrops, and unless these are grown in large quantities even they are not much use to them. When the crocuses commence, if the weather is fine, there is a little more to be found. A fine February day sees the insects crowding to the flaunting yellow blossoms.

But there is not the least doubt that early breeding results from large stores. The larger the stores in the hive after the turn of the days, the more likely is breeding to commence immediately. I have known two colonies side by side, one of which went into winter quarters seven pounds lighter than the other, differ enormously in their spring growth. While the one with ample stores gathered over thirty pounds of honey from the fruit trees, the other one only managed to get four. And yet the latter was headed by a queen in her second year, which is her very prime, while the other was a year older.

IX

REJUVENATION

In this fickle climate of England it is useless to lay down laws and to make definite statements that such and such things will take place at such and such a time. If one were to conduct one's natural history rambles by the aid of dear Gilbert White's Calendar, it would not be often that we should find the things we expected. Over and over again I have found some of the things mentioned in that interesting little compilation not appear for a month after the time stated. Those dates were, of course, the earliest on which he had observed the different things.

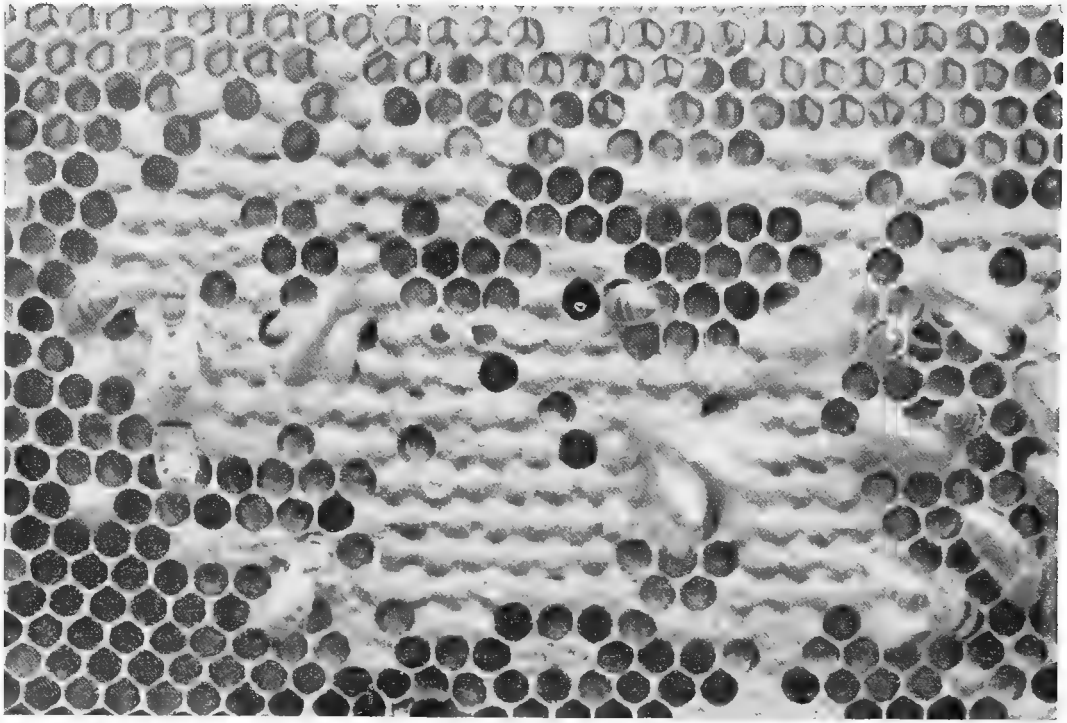
So it is with bees. Sometimes the crocuses are well out and basking in the sunshine by the middle of February. At others they scarcely get a chance to open their blossoms during March, and such few bees as dare to venture out are hard put to it to get anything in the way of provender. However, as soon as some fine warm days come, and there generally are a few in February sooner or later, the hives begin to be stirring. The incoming of fresh stores encourages the queen to lay,

and the centre of the hive is soon full of young grubs in all stages.

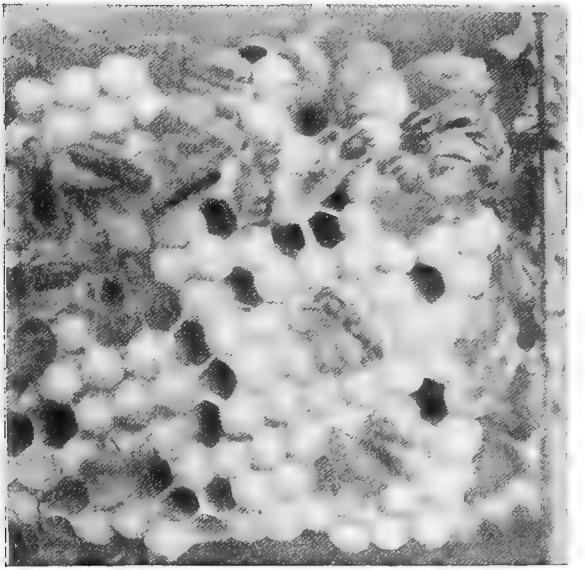
The crocuses are alive with dark, swiftly moving forms, and round about the hive bees are busy coming and going. A great spring-cleaning takes place. The remains of dead bees which have fallen from the cluster, are dragged away far enough for the decomposition of their bodies to have no harmful effects on the living. Old combs are cleared of rubbish such as mouldy pollen, and made sweet and clean for the coming of the queen. The crocuses have hardly done blooming before the sallow blossoms begin to nod in the March gales. These fragrant flowers are a source of great attraction to insects of all kinds. The very earliest bumble-bees, queens which have awakened from their winter sleep and are taking an airing and nourishment to strengthen themselves for the hard labour of nest building, boom round in a joyous ecstasy. Early moths crowd to the blooms in the evening, getting, many of them, hopelessly drunk on the rich nectar. But none are so fond of the soft downy catkins as the honey-bees. Wherever a bush is to be found, thither they crowd in enormous numbers, packing away huge masses of pollen on their legs, lading themselves so heavily that many, alas! never reach the hive, a strong gust of wind blowing them breathless to the ground, from whence they never rise again.

These equinoctial gales play sad havoc among the members of a colony, so much so that when they are very bad and are accompanied by sunny weather, which tempts the bees out, it is no unusual thing for a hive, which has safely survived the rigours of winter, to dwindle away to a mere handful and ultimately perish. Most of the bees which go foraging at this time are very old ones. Unless a large number of bees is reared in the autumn, so that there are strong forces to keep the colony going in the strenuous time of spring, it runs grave danger of perishing.

It is popularly supposed that it is after mild winters that insect life in general is so abundant, but this is not necessarily the case, nor do I think it follows as a general rule. After all, the severity of the winter matters little to creatures who are either resting in the eggs or chrysalis stage, when they are practically immune from the lowest temperature Nature produces ordinarily in these islands, or else are so snugly tucked away under moss or dead leaves that the frost never reaches them. The critical time is the spring, when caterpillars have hatched out of their eggs, butterflies have emerged from their chrysalides, flies and bees come out of their snug retreats to enjoy the tempting warmth of the early year. Let a sudden snap of cold come then, and hundreds will perish. Very wet springs are disastrous too. I remember in the dreadfully wet month



WORKER BROOD.



DRONE BROOD.

NATURAL COMB, VIEWED FROM BELOW.

of June, 1910 (when on two or three days there fell over an inch of rain per day), walking in a secluded part of our forest and finding in a ditch thousands upon thousands of caterpillars which had been washed off the trees.

It is just the same with bees. Given plenty of stores, they will safely winter through the most severe season, but if the spring is wet, cold, and windy, it is the easiest thing in the world for colonies to be completely wiped out if they are not artificially assisted.

By the end of March or early in April, about Eastertime, in fact, the sallows are at their best, and colonies are making rapid headway under favourable conditions. There is then usually, but not always, a little lull in the forward march of vegetation, lasting for a week or a fortnight. During this time there are very few flowers to be found in bloom. After that, the tide commences to flow again, commencing with the gooseberries and currants. Few people are aware to what an extent our crops of these two useful fruits depend on the bees. They are very great favourites, mainly, no doubt, on account of their being the most convenient forage at the time, and they work them thoroughly and systematically. Without them there would practically be no crop at all, for they are almost the only insects which are abroad in any numbers at this season.

Moreover, they are very constant. It is most

unusual for a bee which starts out to visit one particular flower, to go to any other kind on the same journey. If a gooseberry bush in full bloom is watched closely, a bee may be seen flying round it and going from flower to flower with most orderly movement, not leaving until it is satisfied that all that seem fruitful have been visited.

Before the currants have finished, the plums are in bloom, and then, in rapid succession, frequently simultaneously, in fact, come the cherries and pears. Cherries are great favourites of bees, and are thronged on fine days if there are beehives near. They hum round in hundreds, and carry away large stores of nectar and pollen. It is not often one succeeds in getting surplus from the cherry, though once, in a remarkably forward season, I managed to get some. It is rather dirty-coloured, and consequently would not be very marketable if it could be procured, but the flavour is better than the appearance.

The first tree from which really large quantities of honey are obtained—at any rate, in quantity sufficient to provide any harvest for the bee-keeper—is the apple, with the advent of which comes the real work of the year. Colonies reach their maximum and begin to throw off swarms. With this strenuous time we have already dealt.

X

METAMORPHOSIS

It is pretty generally known in these advanced days that all insects undergo striking changes during their lives. Growth is with them not so much a mere increasing of stature as a development of parts, a gradual change from a fitness for one existence to that of another.

Thus the gorgeous dragonfly, the most perfect master of aerial navigation, spends the earlier part of its life crawling in the gloomy depths of a muddy pond in company with many other of the familiar winged spirits of air, such as the caddis-flies, the mayflies, etc. The beautiful butterflies which sport among the flowers in the hey-day of summer, live for a much longer period as mere grovelling caterpillars, sometimes of the most insignificant appearance.

It is this infinite variety of habits, this extraordinary change of life and occupation, which makes insects such a fruitful field for study. The marvel is, not that we never succeed in learning all about them, but that we have managed to discover so much, and it is not surprising to learn that

many of the older naturalists did not even conceive that there was any relation between many of the insects which are so diverse in habits and appearance.

For the most part, insects are able to fend for themselves in all stages of their existence. The mother insect, as a general rule, lays her eggs on the plant or in the substance upon which the young larvæ are to feed, and leaves them to their fate. In a more or less brief time they hatch and at once commence feeding. Having spent the first part of their lives in absorbing all the nourishment they can, they reach their maximum growth, and thenceforth the changes which take place are organic, and produce a creature of very different appearance. Insects are divided roughly into two great divisions—those which undergo a gradual metamorphosis, such as the earwig and the grasshopper, and those in which the change is apparently sudden. The great majority of insects belong to this latter class, and they are characterised by a definite period of quiescence which intervenes between the stage in which they grow and that in which they fly and perform the functions which pertain to the adult stage.

It is during this quiescent period that the wonderful changes in structure and organisation take place. The larva, a simple, sometimes footless worm, is, as it were, melted down and recast

into a more beautiful generally, and certainly always more highly specialised creature. Short fleshy legs are exchanged for elaborate many-jointed feet. Strong jaws give place to a wonderful sucking tube, which can extract the nectar from the tiniest flowers. Simple, almost useless eyes become wonderful, multi-lensed, optical instruments. These and a hundred other changes, almost too marvellous to believe had we not seen the miracle take place in front of us, all occur while the creature is, to outward appearance, dead and lifeless.

It is almost needless to say that the bee belongs to the class which undergoes a complete metamorphosis. Further, in common with its cousins, the ants and wasps, it differs from the majority by attending carefully to its young during its early stages. Instead of laying its egg in the food, the egg is laid in a prepared cell, and food supplied as it is required.

This method of procedure is confined to colonies which live in the social manner, and indeed is so closely bound up with it that it would be hard to say whether the instinct of attending to the young produced the social colony, or whether the habit of congregating in families developed the desire to care for the welfare of posterity. Whichever may have been the case, this desire is manifested in the ants and bees to a most marked extent.

Ants, for instance, although they do not build the wonderful cells of the honey-bee and the wasp, take extraordinary care of the young, helpless larvæ. Anyone who has cut open an ant's nest for the sake of the so-called "eggs," must have noticed that the insects, as soon as they realise that a catastrophe has happened, commence hurriedly to remove the eggs, which are really the pupa, or ants in the quiescent stage, down below.

I was once witness of a curious incident connected with this. I particularly wanted to procure some ants' eggs to feed a spotted woodpecker, and not being able to puchase them, I sallied into our forest to find them. Two species of ant are very fond of burrowing in decayed trees, which lie about the woods there very commonly, and after ripping off the bark of one or two, I came suddenly upon a nest of the larger brown variety, whose eggs are a trifle bigger than those of the smaller black kind, and not so pure in colour. Into a tin I had brought with me, I scooped a quantity of the eggs, and of necessity carried off some of the ants as well, as, had I waited until they were clear of the tin, the eggs would have gone as well. I wandered on a little further, and ultimately came across a nest of the smaller black variety. It was situated under the bark of a fallen tree, and, on tearing off a portion of this bark, I disclosed a considerable quantity of eggs. I set down my tin, scooped a

quantity of the eggs into it with the others, and was about to close it, when it occurred to me to wait and see what the ants would do. For a few seconds they appeared to be running aimlessly to and fro, as if bewildered, as was hardly to be wondered at, by a disaster of such magnitude. In a very short time, however, ants began to catch up such of the eggs as were lying about on the exposed surface of the tree and run with them to the nearest shelter. There they deposited them and ran back for more, while other ants, appearing from below, removed the eggs from the place the last had put them, and hurried them below.

Meantime, in the tin were two kinds of ants, and each of these was running to and fro with an egg of its own species in its jaws. In a very little while the black ants opened up a line of communication with their adjacent nest, while the others, being hopelessly out of their reckoning, ran to and fro. Some climbed over the tin and disappeared, probably to perish. Others continued to run backwards and forwards, while, they being few in number, most of their eggs lay in the tin.

By this time, the black ants, having removed all the eggs which lay on the trunk of the tree, began to pour in a well-organised line into the tin. Each removed one of the eggs of its own species, pushing the others aside, until they were all gone. Having quite satisfied themselves that all their own

offspring were in safety, they turned their attention to those of the strangers, and carried off these in like manner. These being rather larger and the edge of the tin presenting some difficulty in carrying them, they were generally handled by two, one of which approached from below and eased the egg, while the other climbed over the wall.

In a very little time, all the eggs were removed. The black ants then attacked the few remaining brown ones left in the tin. They took away the eggs they each carried, and ran off with them, and then began to make prisoners of the ants themselves. The brown ones were bigger and stronger, and resisted valiantly, but the numbers were too strong for them. Four or five blacks surrounded them, seizing their legs and antennæ and bore them away, except some, who, struggling manfully, were torn in pieces.

My woodpecker had to be content with flies which I caught for him, but it was worth the trouble to have witnessed such an interesting scene.

After this digression I may hark back to the bees. As I said, the eggs are laid each in a separate cell by the queen. Ordinarily, the cells provided for brood are of two kinds. The greater number average across their face five to the inch and are half an inch deep. These are for the worker bees. Drone cells are rather wider, four to the inch,

but they are the same depth. As the body of the drone is longer, extra room is made for him by providing a dome-shaped cap when he is ready to undergo his final change.

The eggs are cylindrical in shape, rounded at each end, one, the head, being somewhat thicker. They are affixed by the tail portion to the bottom of the cell, and stand up in an oblique position towards its mouth. In three days the young grub hatches out. It is, like its eggs, quite white and pearly-looking, and commences, almost immediately, to assume the characteristic semi-circular appearance so familiar to all bee-keepers. It is given only a very little of the special food by the nurse bees at first.

What the special nature of this food is has been exhaustively studied by various scientists and carefully analysed. It is undoubtedly produced by honey being passed through the chyle stomach of the nurse bees. Some think a special secretion is added as it is passed up for the feeding of the grub. Whatever the food is, it is extremely nourishing and easily assimilated, for not only does the grub absorb it by its mouth, but it also bathes in it and absorbs it without any waste matter being produced.

All the grubs are fed on this food for the first three days and those of the queen for the whole time during which she is fed, but on the fourth day the workers and drones are weaned, the

workers having honey and digested pollen given them, while the drones have honey and raw pollen.

Except so far as growth is concerned, the larvæ do not change much for the time they are feeding. As they grow larger, they are given food more abundantly, until in five or six days from the time they emerged from the egg, they have filled their cells and finished feeding. They then spend two days spinning a silken shroud for themselves, the cells are sealed over with a mixture of wax and pollen by the workers, and the larva begins to be transformed into a perfect bee. These wonderful changes have been so well described by the great masters of bee lore that I dare not attempt to do the same. Suffice it to say that, in about a week after they are sealed over, these footless, worm-like grubs become marvellous winged insects, provided with the most wonderful apparatus for sucking nectar, carrying pollen, and making wax, besides possessing numerous other complicated organs and parts.

The rate of development varies with the different kinds of bees. The queen, who is fed the whole time on the special food, completes her transformations very quickly, for her cell is sealed over at the same time as the workers', that is about nine or ten days from the laying of the egg, but she only passes about four days in her quiescent condition, whereas workers take eleven

and drones nearly a full fortnight in which to complete their changes.

As soon as the changes are complete and the white grub has become a brown fluffy winged insect, it gnaws a hole in the covering of its cell and crawls into the open, taking its place among the labourers to assist in rearing a new generation of babies.

XI

THE WEAPON OF DEFENCE

All those who have at any time had anything to do with bees, are well aware that they have the means wherewith to make themselves at times most truculent adversaries.

Like nearly all the other members of the hymenoptera, they are provided with a sharp piercing weapon, which is also the medium by which an irritant poison is conveyed into the body of the victim.

There are some differences between the stings of bees and those of their cousins the wasps, although the general conception that bees are entirely unable to withdraw their stings on account of the barbs is not exactly accurate. It is quite true that the barbs do to some extent prevent or hinder the weapon from being withdrawn, but if bees are allowed time in which to do so, they are able, by a screwing motion, to get the sting out. Generally, however, when stinging is going on, there is such a hurry and excitement that the bee makes a violent effort to pull the sting out, the

result being that the abdomen is ruptured and the sting left behind with a part of the body.

Although the greater number of hymenopterous insects possess a sting, in very many of them the organ does not serve the same function as it does in the bees and wasps. It is probable, indeed there can be little doubt, that the original purpose of the sting was that of an ovipositor. In other families of the order, notably the ichneumon flies, it still serves this purpose. These striking-looking insects lay their eggs in the bodies of the larvæ of other insects, especially those of the butterflies and moths. The apparatus by which they are enabled to do this is essentially the same as that with which the bees inject poison, that is to say, there is a combination of lancets and tubes, connected with a reservoir, which in the one case contains eggs and in the other a deadly poison.

In the queen bee, curiously enough, both these functions are retained, for, although queens use their sting but seldom, they are nevertheless able to do so and with sufficient effect.

Some description, as untechnical as possible, may be of interest. The external appearance of the sting is that of a brown horny prickle. An examination of this prickle reveals the fact that it has on one side a groove, in which lie two lancets, furnished with barbs. These lancets are continued beyond the upper end of the sheath, and

curve over outwardly, until at their extremities they are attached to a lever, which works on a pivot. It is sufficient to say that to this lever are attached powerful muscles, the action of which causes the lever to turn on its pivot. The net result of this arrangement is somewhat similar to that produced by a revolving wheel.

We know that the rim of a wheel must revolve much more rapidly than the hub, so that, supposing the pivot on which the levers turn to represent the hub and the curved upper ends of the lancets the rim, it will be understood that if the turning of the lever on its base is rapid, that of the lancets will be still more so. This is why the bee is enabled not only to insert its sting very quickly, but also to compel it to penetrate such hard substances as leather, notwithstanding its extreme delicacy.

The movement of these lancets forces a quantity of poison down their hollow centres, by the contraction of a bulbous enlargement at the upper end of the sheath. This bulb is not the main reservoir of the poison. This is situated further up, and is connected with the bulb by a pipe, through which it automatically supplies the bulb with poison to replace that driven out.

The exact nature of the poison is not quite clear. Some have supposed it to be simply formic acid; but, although this is doubtless the base of it, there are other ingredients, said to be very power-

ful alkaloids. It is these which cause the extremely painful consequences which sometimes arise from bee stings.

It is most unusual for a bee away from its hive to use its sting against a human being. It is only in actual defence of its home that it does so. Except in the very depth of winter, there are always a number of sentinels posted at the entrance of the hive. Towards the end of the summer, when large stores have been gathered and the sources of honey supply are worked out, this number is increased enormously, until by August or September there is quite a huge crowd of these sentries in the entrance.

Colonies differ enormously in the matter of stinging. Some will not allow anything that looks at all harmful to approach within six yards, a number of bees flying straight out and stinging the intruder. In the majority of cases, however, they do not sting unless absolutely obliged, when, for instance, a definite attempt is made to attack their home. Although the experienced bee-keeper can tell within a little just when it is safe to open a hive and display the contents without smoking the inmates, there are times when a surprise sally is made. I have known, at times, a corner of the top coverings to be only just lifted and two or three bees rush out and sting me immediately. At another time, I might pull the hive to pieces without a single attempt being made to sting me.

When honey is coming in rapidly, bees are always very amiable. They seem to consider that, so long as there is plenty obtainable outside, the loss of a little of their stores is not serious; but the moment the nectar-producing flowers have dried up, it is quite another matter. Caution must then be used in any attempts to take the honey.

All sorts of devices have from time to time been invented and suggested in order to do away with stings altogether. The most ancient and still the most satisfactory is that of frightening the bees with smoke. A good volume of smoke poured into a hive makes the bees most excited. They buzz tremendously, and run hither and thither, their one aim being to fill themselves with honey, doubtless with the idea that if this foul atmosphere continues, they will have to make tracks shortly and may as well go with full bellies. If we open a hive and puff smoke in, the bees are seen to run to the nearest open cells, plunge their heads in, and suck up the honey. By the time they have imbibed a good quantity they are feeling very amiable, and bees that previously showed signs of making a vigorous resistance to the invasion will become as tame as flies, crawling harmlessly about the hands and person of the operator.

The natives of West Africa are said to make use of this method of getting honey from the nests

of wild bees, but it seems curious that, until well on in the nineteenth century, apiarists did not seem to realise that it was not necessary to stupefy the bees completely before attempting to do anything with them, so that if they wished to take the honey without destroying the colony altogether, their practice was completely to stupefy the bees, using for this purpose powdered puff-balls, burnt below the hive until the bees dropped senseless.

Nowadays, such drastic measures are understood to be unnecessary, and the apiarist, to the astonishment of the layman, handles living and moving bees like so many currants, scooping them up in handfuls, shaking them and brushing them from their combs with complete impunity. When honey is coming in fast, most colonies do not even require smoking, but towards the end of the season, at the time when the last crop of honey is being gathered, they become more troublesome, and it is necessary sometimes to use cloths soaked in carbolic acid solution to cover the hives and keep the bees from coming up in a vindictive army.

A very useful device is a kind of valve arrangement, which is slipped under the rack containing the honey we wish to take off. The bees in this rack descend to the main chamber of the hive through the valve, and are unable to get back, with the result that in a few hours the rack is

empty and can be removed without the slightest fear of stings.

The old-fashioned bee-keeper used to take his hives at the end of the season and put them over a hole in the ground in which was burning sulphur. There they remained until all the bees were dead, when he cut the combs out and squeezed them to get the honey. This method is quite out of date, for, by taking advantage of the bees' habit of storing their honey mainly above the brood nest and farthest away from the entrance, we are able to compel them to store in detachable upper storeys, and thus get pure honeycomb uncontaminated by brood. To make quite sure that the queen shall not lay eggs in the upper storey, what is known as a "queen excluder" is placed between the upper and lower. This is a sheet of zinc perforated with holes which are just large enough to allow a worker bee to crawl through, but are too small for queens and drones. We thus ensure not only that the queen shall confine her operations to the proper sphere, but we prevent the greedy drones from eating the honey stored for our delectation.

Notwithstanding all precautions, it will sometimes happen that a particularly vicious colony will prove very troublesome. Horses, for instance, are like the proverbial red rag to bees, and they will sometimes come out in large numbers and attack an animal grazing near—at

times with fatal results, for the horse, mad with pain, will lash his tail and kick his heels up in a manner which only makes the insects more determined to drive him off.

A friend of mine had a hive in a field, and a visitor who arrived on a pony incautiously tied the animal close to it. A bee came out and stung the beast, who immediately kicked out violently. Unfortunately, the blow was planted full on the side of the hive and overturned it. The result was that the poor pony was stung so thoroughly that it died within a few hours.

Personally I have never been stung very much. It is my habit only to meddle with hives at propitious moments, and as I have no fear whatever of bees, I never make jerky movements or jar the combs in my operations. Not but what, when I do get stung, the result is pretty painful. The worst stinging I ever had was on an occasion when a swarm settled in a bough of a tree in my garden, in a position most difficult to reach. I shook the cluster down several times without securing the queen, and, although the bees are very harmless at swarming time as a rule, on this occasion they were so irritated by repeated onslaughts, that they provided me with over twenty stings on one hand, the only place they could get at. I had taken the precaution of wearing a veil, or the result would probably have been unpleasant in the extreme.

Many remedies for bee stings are extant, the blue bag being the most ancient, and as it contains a good deal of ammonia or soda, it is a sound scientific remedy. We use liquid ammonia when we trouble to use anything. Sometimes it relieves at once, but at other times it seems to have no effect. Vinegar, raw onions, and oil of wintergreen are said to be very good, but prevention is better than cure, and, as a general rule, we get very little trouble. A vicious colony should always be got rid of by providing it with a new queen. Some people have a notion that nasty colonies are the best workers, but this is a delusion of a dangerous type. It stands to reason that bees which waste their time rushing out after all and sundry cannot devote all their energies to honey gathering. My most gentle colonies have generally been the best honey gatherers.

One characteristic bees have which will always enable a person pursued by them to escape: they will not enter dark places, other than their own hives, and, by taking refuge in a shed, the bees may be outwitted.

On the whole, where bees are found to be a nuisance, the trouble may be put down, in nine cases out of ten, to bad management on the part of a bee-keeper. The hives should be placed in such a position that the flight of the forager is not interrupted by passers-by, than which nothing is more irritating to them. In the autumn,

colonies which have plenty of store room will prowl round in search of sweets, visiting grocers and confectioners' shops in great numbers. All that is necessary in such cases is to give the hive a feeding-bottle and stop the entrance to the place they have been accustomed to visit for a day or two. This will generally put an end to their thieving propensities.

XII

SOME STRANGE FACTS ABOUT QUEENS

The older writers had a very vague idea about the manner in which the race of bees is perpetuated. It was not until quite late in history that the queen was discovered to be the only fertile female in the hive, and, indeed, in the earliest times she was not regarded as a female, but a king, exalted by some wise dispensation of Providence to the position of a governor and ruler of the whole tribe.

Reaumur, in the end of the eighteenth century, seems to have been the first to call attention to the fact that the queen was a female and "mother of all the others," but it is to the great Huber, who, in spite of the greatest handicap it would be possible for an observer to have, lack of vision, achieved such wonders in the realm of bee study, that we owe our knowledge of all the important principles which govern the life of the hive.

We have said elsewhere that the queen is reared from eggs in no way different from workers, and that she attains her perfect maternal development only by reason of being fed on special food.

Much speculation has been, and still is, rife as to the nature of this food, but it seems to be pretty well established that it is honey and pollen which has been partly digested and mixed with a secretion which can only be produced by newly hatched, or what are known as "nurse bees." When a worker bee leaves her cell, she is a soft, downy creature, able to do little more than wander about the cells. She grows stronger day by day, but it is not for quite a week after she emerges that she is capable of taking her place with the foragers in the field. If a rack of honey sections is removed from the hive in the height of the season and taken away to some distance, it will be found that gradually most of the bees will leave it, and after making a circuit round, in order to locate its position, will return to the hive. If the rack were left there, they would come back again and again until they had removed all the honey. A great many bees, however, will be found to make no attempt to leave the rack, simply hanging on or walking round, and if they are shaken to the ground, it will be found that they are quite unable to fly.

These are the nurse bees, hitherto never having been out in the open, and, even if they could fly, they would not be able to find their way back again. During this week before they leave the hive they are occupied solely in attending to the young bees, feeding them and covering them in

with wax and pollen as soon as they have attained their full growth. It would seem that at the end of the week, when their function as nurses ceases, the secretion which enables them to prepare the food ceases, and they are unable to provide it any longer. If a colony of bees which had lost its queen, and been without for two or three weeks, were given a frame of eggs, it might possibly succeed in rearing a queen, but, owing to the insufficiency of the rich food-supply, she would be of very inferior quality, so that those who make a speciality of rearing queens for market are careful to raise them in colonies which have plenty of nurse bees. For the first three days of their lives, all young grubs are fed with the special food, but at the end of this time worker grubs are weaned, and for the rest of the time exist on plain honey and pollen. Queen grubs, however, are fed for the whole of their lives on the richer food, and it is this alone which transforms them from ordinary worker bees into fully developed females.

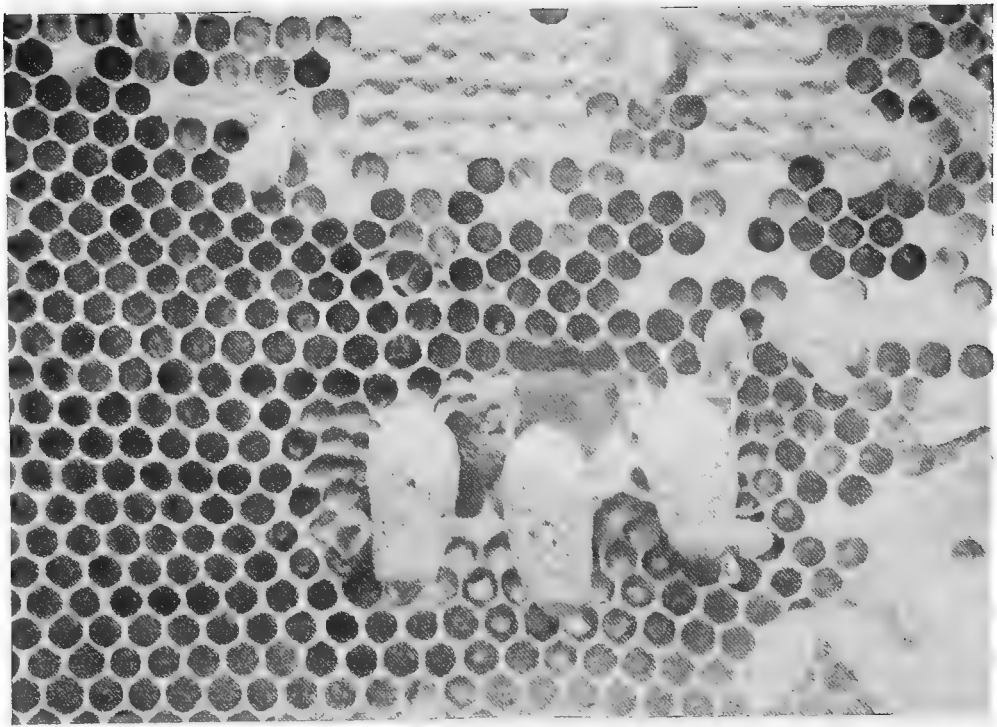
Sometimes it happens that a colony which has lost its queen is found to be still in possession of brood, although it does not appear to make much headway, and indeed dwindles to almost the same extent as an entirely queenless colony. This was a rather puzzling circumstance for some time, until it was at last discovered that it was an ordinary worker bee which was laying these eggs.

THREE STAGES IN THE GROWTH OF A QUEEN CELL.

First day: Worker cells enlarged.

Third day: Feeding the Infant Princess.

Fifth day: Cells nearly complete.



COMPLETED QUEEN CELLS.

The outstanding feature of her offspring is, however, that they are all drones. The explanation of this strange circumstance is said to be, for there is no absolute certainty on the point, although the probabilities are all in favour of the theory, that these fertile workers are bees which have been reared in close contiguity to a queen-cell, and have thus received a certain share of the special queen food after they have been weaned.

As long as there is a fertile queen in the hive, either the laying worker's functions as an egg-layer remain dormant, or the bees decline to permit her to exercise them, but if the queen disappears, the bees make the best shift they can with her progeny. She lacks the method and order of the queen in the disposition of her eggs. A queen goes regularly down the rows, so that the time of her presence at particular parts of the comb can be noted by the age of the brood there, but the worker puts her eggs here and there in a scattered fashion.

Now these eggs are produced by a virgin, and it is one of the things that mankind always considers astonishing, that one sex alone should be able to reproduce itself. I suppose the truth is, we are accustomed to judge everything by our own standard, and, looking upon such a thing as impossible among ourselves, we do not appreciate that it may possibly be so among other

creatures. Yet the truth remains that it occurs in several groups which have nevertheless two well-defined sexes. The aphides are a fairly well-known example, where after the union of two sexes, the progeny produces, without any further sexual intercourse, another generation.

The worker bee, therefore, without being fertilised, produces young, but these young are all drones, or, singularly enough, the opposite sex to herself. It would be difficult to explain how and why this should be the case if it were not that fully developed queens sometimes have the same peculiarity of producing drones only. It was found that when a queen, on account of bad weather or other circumstances, was unable to leave the hive in order to mate with a drone, she nevertheless commenced to lay eggs, but all these eggs produced drones.

To Dr. Dzierzon and Professor Siebold we owe the explanation of these strange circumstances. The latter, an eminent German anatomist, showed clearly that the queen bee has not only within her abdomen two large ovaries full of eggs, but she also has a receptacle which he called the *spermatheca*, and it was found that the contents of this organ differed markedly in the individual cases of a fertile queen and an unfertile one, a fertile worker's *spermatheca* being also similar as regards contents to that of an unfertile queen. It thus became clear that when a queen is mated, the

contents of the *spermatheca* are vitalised, and afford a substance which is capable of altering entirely the nature of the eggs laid by the queen.

Having this theory before them, subsequent scientists have proved it up to the hilt. It is found that an old queen, if she is allowed to live, will after a time produce only drones, and upon the *spermatheca* of these old queens being examined, it has been found that the vitalising fluid has become exhausted. The whole procedure is a purely mechanical one, and comes about in this way. The ovaries have each a tube leading from them towards the vent, both tubes being joined into a common oviduct a short distance from their commencement. Near the point of union there is situated the *spermatheca*, and an opening leads from it to the oviduct. This opening is surrounded by a ring of powerful muscles, the action of which controls the flow of the contents of the *spermatheca* into the oviduct. When drone eggs are being laid, the muscles prevent the flow from the *spermatheca*, so that they issue exactly as they came from the ovary; but when worker eggs are desired, a small portion of the fluid is allowed to pass into the oviduct, and thus the egg becomes impregnated by it. Some have imagined that the flow of this fluid is involuntary, and occasioned by the pressure of the walls of the smaller worker cells

on the queen's abdomen, but it has been pointed out that eggs are frequently laid in worker cells which are only just commenced, when there could not be any such pressure, yet the eggs produce workers. It seems well settled that the queen is able entirely to control the flow from the *spermatheca*, and thus produce either workers or drones at will.

Another circumstance which was unknown to the older observers is the fact that the queen must leave the hive before being mated. The drones are incapable, from their peculiar anatomy, of exercising their functions except on the wing. It is thus necessary for every queen to leave the hive in order to be mated. This is a circumstance entirely favourable to the welfare of the community, for it is a well-recognised fact that inbreeding tends to degeneracy sooner or later. Moreover, although the queen flies seldom, she flies well and swiftly, and, therefore, it is only the strongest and swiftest drones which are able to catch her when she does leave the hive. There is thus a constant tendency for the race to be developed in wing power, and indeed a great field is open for the careful apiarist to raise by selection a race of very swift, strong bees.

Great precaution is taken by the queen to ensure her own safety when she leaves the hive for her wedding flight. It is the only time she will ever be mated, and, indeed, unless she goes out with a

swarm in the future, she will not again seek the outer world. She chooses a fine day, usually in the early afternoon. At that time the drones are flying about all the hives. When she first leaves the hive, she goes only a little way, as if to exercise her wings somewhat, and also to locate the hive and its surroundings, for if she returned to the wrong hive, she would be killed immediately she entered.

Having made perhaps three or four little excursions of the kind, she at last makes her long flight. Leaving the hive, she rushes swiftly away into the upper air, and is followed by a crowd of drones, varying in number according to the condition of the apiary.

At a great height, the mating with the drone who is fortunate enough to catch her takes place. In the operation, the drone is badly injured, being unable to set himself free from the queen. He falls dead, and the queen returns to the hive with a portion of his organs adhering to her. The watching bee-keeper hails this trophy with delight, for it is the surest sign that the mating has been safely accomplished.

In a well-ordered colony, practically no notice appears to be taken of this proceeding, the queen being left to do exactly as she pleases; but in the case of a small colony which has been queenless for some time, and has no brood in the hive, it sometimes happens that the whole

colony leaves with the queen on her wedding flight.

It would seem that, knowing themselves capable of rearing another queen, and, indeed, having other young queens in their cells, in case anything happens to the first, they are not concerned, but when there is no such reserve in the hive, they consider it necessary to form a strong bodyguard to protect their only hope.

When the queen returns to the hive duly fertilised, she first removes the adhering portions of the drone, and then commences to destroy all the other queens in the hive, displaying a most bloodthirsty desire to perform this duty. In some cases the workers assist her, but when the hive is still very thickly populated with bees, they sometimes, seeing the advisability of a further migration, prevent her from doing so, and when this is the case, she, failing in her desire to annihilate her rivals, rushes from the hive, together with a number of the bees. Sometimes these second swarms, as they are called, are almost as large as a first or prime swarm, but in general much smaller. In some hives this proceeding takes place several times, at intervals of two or three days; but, from the bee-keeper's point point of view, it is desirable in most cases not to allow more than a first and second swarm to take place, as the hive is seriously weakened and the casts are of little value. By cutting out all the

queen cells but one after the first swarm issued, this after swarming can easily be prevented. A skilful apiarist uses the cells he thus cuts out to supply other colonies with new queens where necessary.

XIII

A PROBLEM OF HEREDITY

The subject I am about to touch on in this chapter perhaps trespasses rather far into the domain of the ultra-scientific, but it is so curious and fascinating in all its aspects that I cannot refrain from discussing it at some length. I shall try and make the matter clear without the use of scientific terms with which to bewilder the reader.

From what has been said in the last chapter, it will be seen, on a little reflection, that drones have a mother, but no father. How comes it then that they possess the virtues, or perhaps we should say vices, of a parent who has taken no part in their production ?

Of course, it is true that the drones which come from a certain queen are generally pure, that is to say, the particular variety of bee, whether Black, Italian, or Carniolan, which the queen belongs to is perpetuated in the drone, although there are cases where the drones are not pure. Several reasons have been put forward, two of which at present hold the field, though neither is conclusive.

One is that the drone has so affected the ovary of the queen that some of her eggs are tainted with his characteristics, even though they produce only drones. Another suggestion is that the food conveyed by the nurse bees to the young larva makes a great deal of difference to its development, and that larvæ always partake to some extent of the characters of the colony, even though it may be headed by a new queen of an entirely different race. In any case this could only apply to a limited number, at least so far as the workers of the original colony were concerned, as each succeeding generation of nurse bees would have less and less of the original colony's characteristics, so that by introducing a pure mated queen of a different race to the original colony, we ultimately change the whole colony into a new race—that of the new queen.

But so far as the drones are concerned, you may carry the investigation back as far as you like, back through successive generations of queens, and still you fail to reach a point when you can definitely say the drone characteristics which unfertilised eggs bear have been acquired.

To put the case another way, the position appears to be this. The female, or queen bee, contains within her own person the means of reproducing bees, but not bees which are in any way like herself. Her unassisted progeny is of a kind entirely different in its

organic structure. In this she differs from the aphides. The offspring of a virgin aphis is like herself, a female. Up to a certain number of generations, females can thus be produced by females. Difficult as this is to understand, it pales into positive simplicity when compared with the case of an insect which produces something entirely unlike itself. But this is not all. The union with the male produces an insect which is like neither father nor mother, except so far as the worker bee has rudimentary and for the most part useless female organs.

Still another aspect of the question seems to defy explanation by any of the known laws of heredity. It is generally understood that, subject to the laws of variation, under which no two creatures are ever exact counterparts of each other, like does produce like, and that qualities possessed by parents will be transmitted more or less faithfully to their posterity. Thus lions of a fierce race will produce lion cubs whose nature will be expected to be as fierce, more or less, as their parents. Sometimes the characteristics of one parent are more prominent in the offspring than those of the other, frequently to the apparently entire exclusion of the other parent's qualities. In the case of mules, there is a mingling of the characteristics of each parent to an extent which is sometimes almost ludicrous. So universal is this rule, that it is with the greatest difficulty that

we can understand how it could possibly be otherwise. And yet, what, so far as the bee is concerned, are the actual facts ?

The drone is a male bee, having neither the organs nor the intelligence to perform the necessary functions of existence apart from the colony. The queen is more or less in like case. Neither is able to find food for itself. Neither has ever had anything to do with the rearing of the young. Yet the product of the two is, under ordinary circumstances, an insect endowed with special apparatus for carrying home honey and pollen in quantities truly remarkable for the size of the creature. Its tongue, honey sac, and pollen baskets are developed in a measure that has no comparison with those of its parents. In addition, it possesses a much higher degree of intelligence, as calculated by brain area. That there is some clear reason for this and that it is not merely a singular caprice of nature we are quite ready to believe, but how it is to be explained is another matter.

Skilled apiarists know well that qualities, even to the most minute shades of difference, are thus perpetuated. A stock that is naturally vicious and inclined to sting at every opportunity can be cured of the propensity by removing the queen and substituting one from another and more gentle colony. On the other hand, if we have a colony which is notable for its devotion to work, for its

capacity to extract honey from specially inaccessible flowers, or for the exceptional colour and beauty of its wax, we take great pains to rear future queens from that colony, knowing that their offspring will assuredly possess the same qualities. And yet, so far as we can trace back through the ages, the queen has never performed any of the duties so pre-eminent in her offspring. At present the matter would appear to be beyond solution. The nearest approach to an explanation is that which we have already mentioned, advanced by Grimshaw, that the food supplied by the nurse bees plays its part in the development of both drones and workers.

That, reasonable as this suggestion may be, it does not approach to anything like a solution of the problem is quite clear.

XIV

EVOLUTION APPLIED TO BEES

This problem of heredity does not stand entirely alone, although it is, perhaps, the greatest difficulty in a very complex case. It forms, as it were, the one outstanding rock in a swirling, foaming sea that appears entirely unnavigable. As we approach nearer, we discover other rocks, some almost as prominent as this, others half-hidden by the breaking waves, while how many are lying in wait, unseen as yet, we cannot tell.

When you come to think of it, it is a little difficult to account for the honey-bee's existence at all. It would seem that the difficulties in the way of perfecting such a creature would be enormous, if not insuperable, under the accepted rules of "the survival of the fittest" and the "tendency to vary." There are, one can well imagine, plenty of other lines on which the ancestral insect might more favourably have developed. Presumably the bee comes from the same ancestral stock as the wasp. At the same time it has contemporaries coming from the same source which have not the social habit, nor

anything that appertains thereto. Having regard to the fact that the workers possess atrophied organs of sex, we may fairly claim that originally the insect possessed powers of reproduction and was presumably a solitary creature.

Is it not peculiar, then, that two such definite lines of development as those of the bee and the wasp should take place? For consider how entirely different the two are. The wasp, feeding on honey and animal matter, the bee on honey and pollen; the wasp building vertical cells, the bee horizontal; the wasp constructing those cells of an alien material, the bee of a substance derived from its own body; the wasp maintaining a number of queens, the bee only one; above all, the wasp being an annual colony, sinking to nothingness, and only surviving as a few scattered members in the winter; the beehive a permanent establishment, lasting, as in some well-accredited instances, for fifty or sixty years. How are these things to be explained on evolutionary lines? For, consider the difficulties in the way of the bee's survival. On one solitary female the existence of the whole colony depends. At very most three or four new colonies are formed each year.

Supposing a swarm to issue in the height of the honeyflow. It betakes itself to what appears to be a suitable location, but which may prove, when winter arrives, if it survives till then, a most

unsatisfactory place in which to pass the cold, damp days. And suppose the honeyflow fails, as it not seldom does fail, just when that swarm is well started in its new home. There may be days, and even weeks, wherein nothing is yielded by the flowers. The workers dwindle and die, and no young ones are reared to take their place. If the weather mends later, the flowers have perhaps ceased to give nectar in any quantity, and the result, the inevitable result, is starvation before the winter has passed. Even if such a colony braves all those perils, when the cold winds of spring begin to blow and the workers go abroad in numbers for forage, they are lost in hundreds and the colony dwindles away. How much more satisfactory to lie completely dormant during the dead months, even if the opening days of spring mean hard, single-handed labour!

Or again, suppose in the very opening days of the year, in February or March, the one solitary queen dies. There may be larvæ young enough from which to rear another, but where are the drones who are to complete the work? It is a well-established fact that unless a queen is mated within a limited time of her emergence, she becomes incapable of fertilisation and a drone breeder, producing a race of useless members, so far as carrying on the work of the colony is concerned.

It must never be overlooked when thinking of

bees that, although the queen is so prolific, her progeny to all intents and purposes do not increase the number of bees available to form a new generation. The fly which lays a hundred eggs in its life produces by compound multiplication far more descendants than the queen laying two thousand eggs a day.

I confess I find this a hard nut to crack. Everything in the life of the bee would seem to have been evolved on the most difficult lines, and we can only say that had it been the design to produce a highly specialised creature under the most impossible conditions, and in spite of the most adverse circumstances, no better line of evolution could have been chosen.

There are certain sub-issues which only seem to make the problem more difficult of solution. For instance, it is pretty generally believed that the sting of the bee is a modified ovipositor which, in the ancestral form, served the same end as it does at the present day with the *ichneumons*. If we grant that in the worker bee the disuse of the weapon for its original purpose was accompanied by a specialised evolution into a weapon of defence, we seem to be on fairly level ground. But what then becomes of the queen who has a sting as well as an instrument for egg laying? Presumably the queen has always laid eggs. How then did she develop a separate sting?

These problems stagger me when I come to

think of them in connection with the theory of evolution, and I am bound to say that, reasonable and even probable as the theory appears, there are undoubtedly cases which would appear entirely to negative it.

XV

DISEASES OF BEES

Almost every organism to be found in the world has one or more troubles in the way of disease that are peculiar to it. Those attached to many insects we know little about, but bees being so important to mankind from a commercial point of view, much pains have been taken to discover the causes of the strange and startling death of bees from time to time. Many an old-style bee-keeper has found his charges suddenly disappearing. He may have seen them working hard one day, apparently in the best of health and spirits, and a few days later he has found them all gone, except perhaps a few crawling and sickly creatures lying on the ground or among the combs.

In the winter, when bees are left unattended, they sometimes die right out, and when the hives are opened in the spring, nothing but a heap of dead bees is found within. In many cases this is due to starvation, pure and simple. If bees do not have at least twenty pounds of food in the hive at the end of September, they

will, almost surely, be completely destitute by March, for not until that month is there sufficient honey to be found to keep the colony going. In such cases the bees will generally be found buried in the cells, to the bottom of which they have crawled in a last despairing effort to obtain food. The sight of such combs is heart-rending, and should fill the neglectful bee-keeper with severe remorse.

But if absence of food is bad, unsuitable food is only a degree better, and a very common complaint amongst bees is dysentery, which is brought on by unsuitable food. In domestic apiaries the cause is usually attributed to food being given to bees too late in the season. After the end of September it is almost impossible for bees to work their wax, the temperature being insufficiently high, so that if food is given them after the middle of October they are unable to seal it over. The consequence is that it ferments, and causes the unpleasant disease named above. It may also be brought on by giving impure sugar. Sugar which is given to bees should always be pure cane. Beet sugar contains certain salts of potash which are bad for bees, and the raw sugars contain a great deal of waste matter which, if retained too long in the system, is sure to bring on this trouble.

It does not occur in the summer, because the insects are able to get out and discharge their

excrement before the accumulation is too great. When this disease is in the hive, the bees soil the combs most unpleasantly and dwindle rapidly away.

From this it will be seen that, as a general rule, bee-keepers themselves are to blame if dysentery breaks out, although it is believed that it is sometimes brought on by bees eating honeydew.

Honeydew is a curious sticky substance which in dry summers may be found on the leaves of very many plants and trees. It is an excretion from the plant induced by the attacks of aphides. Probably most people have at some time or other noticed this stickiness. Insects are very partial to it, and I have taken many kinds of moth in the evening feasting upon it. Ants eat it greedily, and so fond are they of it that they hunt out the aphides and milk them. I have often seen them doing this, and in my garden there are several trees which, so surely as summer comes round, are bound to be covered with ants searching eagerly for their cows. If an aphis is closely examined, there will be seen two little tubes on its back standing up, from which, by tickling the insect with its antennæ, the ant causes the honeydew to flow.

As a general rule, when honey is abundant, bees do not collect honeydew, but in some seasons it is stored in great quantities, and it is, as I said

before, considered very bad for them to winter on.

The most characteristic form of disease to which bees are subject, however, is that known as Foul Brood. This disease is caused by a bacillus, and is extremely contagious. It takes various forms, which are attributable to slightly different varieties of bacillus, but in either case the affected members of the colony are the larvæ or grubs. At a certain stage, instead of developing into bees, they become flabby, turn brown, and shrivel up. In the virulent form the larvæ, after decomposing, smell most vilely, and, if a pointed stick is inserted into a cell, it is found, when withdrawn, to have a brown sticky substance adhering to it, which can be stretched like rubber.

This disease may exist in a hive in a mild form for years. Many people who do not give the attention to their bees which they should, have found, when their hives have been examined by an expert, many if not all of them, infected with the complaint. The great cause of contagion is the robbing of such hives. Naturally, when a hive is suffering from this complaint, it tends to become weaker in proportion to the extent of the disease, and the weaker a colony is, the more liable is it to be attacked and robbed by strong colonies. These robber bees carry home the germs or spores with which the honey becomes tainted, and so transmit the trouble.

Fortunately, several drugs have been discovered which will overcome this disease, and indeed, where hives are thoroughly cleansed and disinfected every spring, it seldom makes its appearance. The unfortunate part of it is, that quite a number of people buy one or two hives of bees, and after perhaps getting a severe stinging on one occasion, never go near the hives except when they want honey. Can it be wondered at that once the germs of disease are carried into such a hive, it increases and multiplies and becomes in its turn a source of infection ?

Until a year or so back, Foul Brood was the worst enemy the bee-keeper had to contend with, but in 1906 a disease broke out in the Isle of Wight and wiped out nearly every apiary there. No cause could be assigned for this trouble, which manifested itself in the bees having greatly distended abdomens and being unable to fly. They came out of the hive in increasing numbers until the whole colony was destroyed. After a year or two's interval, the disease broke out on the mainland, and raged in Hampshire and Surrey to a greater or less degree all through the bad summers of 1908, 1909, and 1910. It then spread to an alarming extent in every direction, although it nowhere appeared to be so bad as it had been in the Southern Counties. No doubt the spread was accounted for by the practice of sending "driven bees" from Hampshire to all parts.

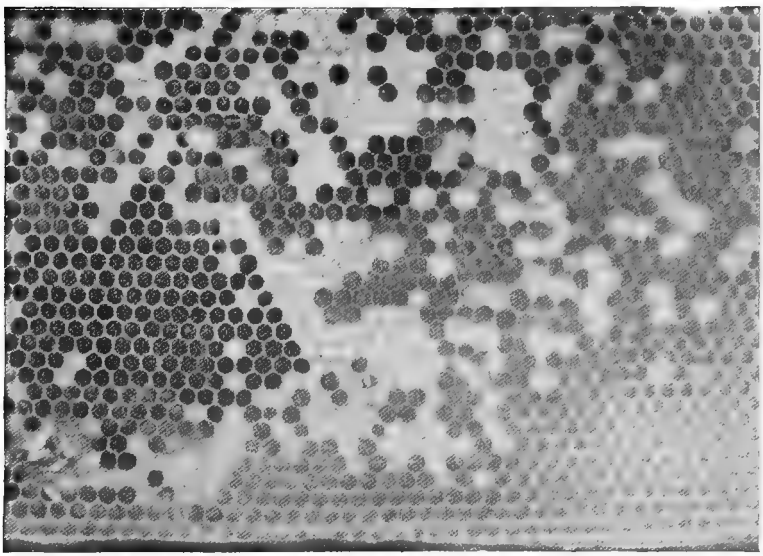
In the fine summer of 1911 there seemed to be some check put on the disease, but even now no certain means have been discovered of curing it. It is believed to be caused by a protozoal parasite which inhabits the digestive tract of bees and is transmitted by means of the food supply, which, being carried away by bees, becomes a medium for its spread.

The check put on the disease in 1911 shows that sunshine is beneficial to bees, and it is my own view that hives should always stand where they get the maximum. There is no germicide like sunlight, and, combined with a proper cleansing of hives every year, if it were universally practised, most of these troubles would cease.

There is a larger parasite attached to bees known as the blind louse, or scientifically, *Braula cæca*. It is somewhat smaller than the plant lice, and is reddish-brown in colour. The eggs of this creature hatch inside its parent, where the larva lives until it has attained its full growth, when it drops to the floor and becomes a pupa. On emerging as a perfect insect, it attaches itself to the body of a passing bee, ready for another cycle of transformations. The queen bee, owing to her long life, is often thoroughly infested with these things, but they do not appear to do much harm, although, as their nourishment must be at the expense of the insect, no doubt they would be better without them.

Although these are the principal maladies from which bees suffer, they are by no means all. Quite a number of other complaints have been noted from time to time, such as Bee Paralysis, which is noticeable in that it causes them to drag their hind-legs along motionless, their wings tremble, and they are unable to take flight. From time to time bees are reported as having certain strange symptoms. Many of these cases have, so far, not been satisfactorily explained, and although no doubt many of them are but variations of the others, there is no room for doubt that the bee people have endemic diseases among them which we do not yet fully understand. Whether *they* do is another matter, but I see no reason why there should not be doctors in the community. Otherwise we must conclude that those cases in which a disease has become manifest and then disappeared have been merely good fortune.

A BUSY TIME.



BROOD OF A FERTILE WORKER: DRONE COMB IRREGULARLY SCATTERED.

A NEWLY HIVED SWARM
(Bees fanning to signal the news to flying bees).

XVI

BEES AND THE WEATHER

The connection between the occupants of the hive and the changeable elements is a very close one. It would be fairly safe to say that no animal life is so entirely dependent on the nature of the weather conditions, and hence bee-keepers have from time to time associated certain weather with particular phases of bee life. In some quarters, indeed, it began to be believed that bees had a kind of prescience in this matter, and could foretell the weather with a certainty that man could never hope to approach to.

Since mankind has made a science of weather recording and observing, we have changed all that, and we now know that bees know no more than we do, if so much, of the coming conditions. Possibly being more closely dependent on it, they formerly did know more than we, for as a species mankind is not a closely observant animal, or if he observes, he does not seem to have the right knack of applying his observations.

The old-fashioned bee-keepers used to say that when swarms began to leave their hives, fine

weather was bound to continue, so that in that respect they were looked upon as a kind of weatherglass. That, as a general rule, fine weather prevails at and after swarming time there can be little doubt, but it is by no means an invariable rule. The truth is, that bees do not, as a rule, swarm unless the weather is already favourable. They seldom issue from a hive in cloudy or windy weather, and it follows that when the air is calm and clear, the time, in fact, when swarms issue, the conditions are usually more or less settled. Mankind, if gifted with the faculty of observation, can premise this settled period without reference to the bees at all.

On the other hand, I have known swarms leave their hives on a fine day which was sandwiched in a period of wretched, unsettled weather. The original preparations for swarming, the building of queen cells, etc., are begun many days ahead of the actual swarming. If the weather changes after the queen cells are commenced, they are sometimes cut down and swarming put off until the weather improves. On the other hand, they may be left, and the young queen may actually come out of her cell and remain separated by the bees from the old queen during the bad period. On the first fine day, however, the swarm will issue, and it sometimes happens that in the excitement the young queen comes out herself, and the unusual sight is seen of two clusters from the same

hive hanging close to each other. Often I have known the weather so bad after swarms came out that they had to be fed or they would have starved, and in natural circumstances they would do so.

Then again, many old bee-keepers will tell us that bees do not go foraging in any numbers, however fine the morning may be, unless it is going to be a fine day. They say, in fact, that if bees fly out in great numbers in the morning, however dull it may be, the day will be fine. This is founded on altogether a wrong basis. Practically the only things which affect the egress of the bees are temperature and abundance of honey. When the hive is warm, more bees are able to go out, and, other things being equal, more go when the sun is shining than when the sky is overcast. If bees are seen leaving in large numbers on a dull morning, it may be taken for granted that there is an abundant flow of honey on somewhere and they are determined to lose no time in getting it. Often I have known bees going out like this in the morning, working with tremendous energy, and the afternoon to be pouring wet. Again, on a sunny day, if a cloud comes up and covers the sun, bees will race home from the fields as hard as they can, the noise of their returning wings being so great that I have sometimes been deluded into the idea that they were swarming.

Some time back I made a long series of observa-

tions on the weather as related to bees. By weighing a hive each day over the whole period from April to August—during which honey is ordinarily gathered—and tabulating the gains or losses against the various features of the weather as indicated by the barometer, thermometer, hygrometer, rain gauge and wind vane, I was able to form a very fair estimate of the conditions necessary to enable bees to thrive and store honey in large quantities. For the sake of comparison I weighed two colonies, one of which was a very strong one, the other rather weakly. The results were extremely interesting.

As compared with the barometer, the bees' efforts seemed to rise and fall with it, for, although the readings of this instrument were extremely high over the whole period and the weather correspondingly settled and fine, when I divided the readings into three parts, high, medium, and low, I found an exact proportion of gain had been made by the bees; that is to say, on the days of medium pressure, the bees gained on the average twice as much as those on low pressure, while again, when the barometer stood high, the gains were double those when it was of only medium height.

With the matter of temperature, when the mean maximum was over 75 degrees F., the gains were very much greater than when it was between 66 degrees and 75 degrees. These gains

were better than those days of temperature ranging from 55 degrees to 65 degrees and so on down to the lowest readings, the difference in each case being most marked.

I found that wind exerted a tremendous influence on the honey-storing powers of these two colonies, for the surplus gained when the wind was light was more than four times that secured when strong breezes were blowing. But, above all, the presence or absence of sunshine was the principal factor, for the average gain over the whole period when the day was clear and sunny was more than one pound in each case, whereas, when the sky was overcast, there was an average loss of about two ounces per day.

These observations were made during the course of an exceptionally fine summer, but it is easy to see that in a long spell of changeable, uncertain weather the bees would suffer very greatly. The period during which honey can be found in sufficient quantity to provide a surplus is comparatively limited. It commences with the blossoming of the fruit trees. Only very rarely is the weather sufficiently good during that early season to enable colonies to do more than keep brood rearing going steadily. To secure surplus honey from those sources is quite an achievement in even a well-regulated apiary where bees are never allowed to run short of stores. How much more difficult then, when, owing to a shortage in

the previous year, the winter supply has only been just sufficient to go round.

After the fruit trees have ceased blooming, there is a period, sometimes running into six weeks, when very little surplus honey is gathered. Not till the white clover comes into bloom are colonies able to store anything over and above daily needs, so it is vital to the welfare of each hive that the weather should be good when that insignificant little flower is out. Wet weather not only prevents the bees going out, but seems to wash the honey out of the flowers.

On the whole, I believe that warm weather, providing it is accompanied by sunshine and a somewhat humid atmosphere, is the most favourable. The detailed investigations I made in 1911 rather negatived the idea that humidity was favourable, but as showing how unwise it is to draw conclusions from a limited set of conditions, the following year proved a far better one from the honey-storing point of view, notwithstanding that the weather was not at all settled. 1911 was a very dry summer, remarkable for the fact that very little dew fell, and the only occasions when there was a high rate of humidity were times when heavy rains fell. On the other hand, in 1912, although there was not so much uninterrupted sunshine, the rains were not so heavy, while the air contained more moisture at all times. It is probable, indeed it is most

likely, that this humidity assists in the development of honey in the flowers and, at any rate, it must enable them to absorb moisture each night, not only by their roots, but leaves and petals, and presumably this acts beneficially on the secretive organs.

There is no doubt whatever that it would be a very fascinating study, which might be extended over many years, to ascertain exactly what the conditions were under which bees did best, and from a practical point of view it would more than pay to do so, especially if various strains and races of bees were tested against each other, for there is no doubt that some kinds work better than others under adverse conditions. Most of those who keep what are known as Italian bees, say that they do not hurry home when clouds come up as black bees do.

Thundery weather has a bad effect on bees' tempers. When the barometer is high and the sky bright, they seem much more amiable, but when electricity is overpresent in the air, these insects seem to catch the prevailing depression and become very irascible. Bees that under ordinary conditions will allow one to pull the hive to pieces without resenting it, will, on such occasions, frequently sally out and attack persons a few feet away from the hives.

The same thing happens at times when the weather suddenly becomes cold. On such cold

evenings, if one only turns up the corner of a quilt, a number of bees will rush out and sting without giving the slightest warning.

On the other hand, there can be little doubt that mild winters are worse for bees than severe ones. Although medical men tell us that severe weather has, on the whole, a worse effect on the death rate than mild winters, we all know that people who would be quite healthy and vigorous during a severe winter, are continually having coughs and colds when the season is protracted and changeable, even though it is comparatively mild.

With bees it is quite certain that sharp winters are best, for when the weather is very cold, they hardly move at all, but simply lie clustered in a semi-torpid condition. This economises stores, and thus colonies which have perhaps only a small proportion of stores will pull through quite easily. If, on the other hand, the weather is changeable and mild, the insects move about freely, breeding goes on in a fitful and interrupted condition, and the consequence is that the food is rapidly consumed. When the spring comes, and activity becomes general, the shortage is so great that with increased breeding there is not sufficient food to last until the flowers commence to bloom. The colony rapidly dwindles and dies out.

XVII

BEES AND FLOWERS

USEFUL though the honey-bee is to man by its direct production of honey and wax, its beneficial influence by no means stops short there. Indeed, it is pretty safe to say that its indirect usefulness is inestimably greater than its more obvious economic value. For, while numerous insects play to some extent a part in the fertilisation of flowers, not one performs anything like the amount of work of this kind which is done by the honey-bee. Several notable naturalists have published exhaustive treatises on the adaptation of various insects to the flowers they visit, and therefore it is unnecessary for me to enter into details. Those who have not read Lord Avebury's book on the subject should do so.

The reason why bees are so extremely useful in this fertilisation process, is, of course, that they require the fertilising matter, which we call pollen, for their own consumption, and, therefore, they make regular and systematic journeys after it, even when there is no honey obtainable. Pollen

is produced by flowers in an abundance entirely out of proportion to the amount required for fertilisation, so, although the bee may take for itself much more pollen than it distributes, it yet distributes sufficient for the requirements of the flowers. The next feature which makes the bee pre-eminent as a pollen distributor is its methodical way of working. While it is not quite accurate to say that bees only visit one particular kind of flower on each journey, for all practical purposes it is so, and one has only to watch a bee which is working, say, on Canterbury bells, to see how it passes over all the other kinds of flowers in journeying from one plant to another. Why this should be so is rather a matter of conjecture. It may be that it prefers not to mix different kinds of honey or pollen, just as we ourselves, if intending to pick fruits from the garden, would probably make different journeys, or, at any rate, use different receptacles for raspberries and strawberries. As the bee has not the power of using different receptacles, it is forced to make separate journeys.

I am very much inclined to think that this explanation, simple and perhaps unscientific as it is, is the true one, although I am well aware that it might possibly have been brought about by natural selection favouring those bees which habitually adhered to one kind of flower. At any rate, it may be taken as a fact that as a general

rule pollen is only collected from one kind of flower on a journey. Various observers have examined hundreds of loads of pollen from foraging bees, and in comparatively few cases have these been of an assorted nature.

From this habit of the bee it will be readily seen how little pollen is wasted, for that taken from one flower is almost sure to be carried to one of a similar species. The bee likes to have its pollen nicely packed away before going on to another flower, and it is one of the prettiest of nature's sights to see a bee collecting pollen. Diving into the flower, it brushes and scrapes away the pollen until it has as much as it can manipulate comfortably, when it makes its way out. Passing its forefeet to its mouth, it moistens the particles, and then rapidly transfers them back to the pollen basket, which is furnished with an ingenious arrangement by which the pollen is tightly compressed and made to adhere firmly. All the while it is doing this, it supports itself almost motionless in the air, its wings vibrating with a most joyful hum. Having packed this lot away, it either returns to the flower or passes to another one, although some flowers yield enough for many loads. I have noticed three or four bees working on a single poppy almost all the morning. Poppies contain enormous quantities of pollen, but it is curious that bees only visit them in the morning. Quite as early as five o'clock they will be at them,

coming and going with immense loads until about ten, when they leave them.

To the fruit grower there is no doubt whatever that bees are quite essential. It has been proved over and over again that when bees are located near an orchard, it becomes vastly more productive. And it is not necessary to look far for the reason. Such things as gooseberries and currants must be fertilised by insects. Insignificant as the flowers are, they secrete a large quantity of nectar, and are thus very attractive, but bees are almost the only insects which are abroad in any numbers at this time of the year, so that without them there would be no fruit at all.

Above all, the papilionaceous flowers, such as clover, beans, etc., need the visits of insects, and in this connection I have noticed an extremely ingenious trick which goes far to show, in my opinion, that insects act with reason at times.

In the common broad bean I once noticed bees working round the base of the flower instead of going into the mouth, and upon inspection I found a tiny hole had been bored just at the point where the nectary is situated. A large number of flowers had such holes, which were being visited by all kinds of bees as well as ants, and although I was not able at the time to find out what had caused this hole, on a subsequent occasion I watched a row of beans which were just coming into flower, and saw a bumble-bee

deliberately tearing the hole with its jaws and afterwards sucking the honey. Insects which followed made use of this opening, and thus saved themselves considerable labour in passing in and out of the flower. From the flower's point of view this must be serious, for if, in course of time, bees universally made a hole in this way, where would be its fertilising medium ?

Bees sometimes collect both honey and pollen on the same journey, but when the honeyflow is really on, it will generally be found that the majority leave pollen gathering alone, while in the early part of the season many go out solely to collect pollen, procuring it from flowers which do not give honey at all. I have several times seen bees getting pollen from the grasses, which are, of course, generally wind fertilised.

In the early part of the year, where such trees as the hazel and the sallow do not flourish, it is customary to provide artificial pollen in the shape of pea or wheat-flour sprinkled on chopped hay. The insects will make use of this until plenty of natural pollen is available, but desert it as soon as flowers appear in numbers.

I have said that the greater number of our garden flowers are not attractive to bees, and this is the case, but there are a large number of such flowers of which bees are very fond, and if grown in sufficient quantity they would no doubt be able to store honey in large quantities. Those

who wish to attract bees of all kinds should make a point of growing borage, anchusa, Canterbury bells and, indeed, campanulas generally. I know of a monastery garden in Surrey where a wide border of Canterbury bells is always grown, and resounds from morning till night with the murmur of bees.

Clarkias are favourite flowers, blooming in the late summer when field flowers are nearly over, and at the same time the stately hollyhocks prove very attractive. Bumble-bees visit them in hundreds, but the hive-bee only does so when other things seem to have failed. They get as dusty as millers when working in these extremely pollinaceous flowers.

Mignonette contains a good deal of honey, and attracts bees in numbers, but there is perhaps no greater favourite than that beautiful purple sedum which flowers at the end of August, bearing great masses of flowers on every clump. I have seen scores of bees at work on this flower, disputing with the peacock and tortoiseshell butterflies the priority of possession. Such a clump will almost surely provide for the lover of Nature a thousand varied scenes of insect life, if he have the patience—as all true lovers of nature should have—to watch it day by day.

XVIII

NATURAL ENEMIES

It is but natural to suppose that bees have a great many difficulties, besides those attendant on climate and the struggle for daily bread. The possession by them of such a formidable object as a sting can only be accounted for on the supposition that they require one. It would open up a very wide field of discussion if we inquired whether the bees' honey-storing habit rendered it necessary for them to have a sting, or whether the honey could never have been stored if they did not possess one. Wasps, as we know, have stings, and so have bumble-bees, yet they never store honey to the extent that bees do. On the other hand, wasps are predacious, and in their attacks on flies and similar small fry no doubt sometimes catch a tartar, when their sting comes in useful.

But, however we may look at it, the mere fact that bees store honey, a substance perhaps more widely appreciated amongst living creatures than any other single foodstuff, makes it quite certain that they will have enemies.

These enemies are drawn from every order of

living things, and it is characteristic of life in general that the most formidable ones are the most insignificant in appearance.

Scattered throughout the preceding pages are references to birds, toads, and similar enemies. These are only, as it were, casual ones, catching a stray bee or so here and there. But there are others who make it their special business in life to attack bees.

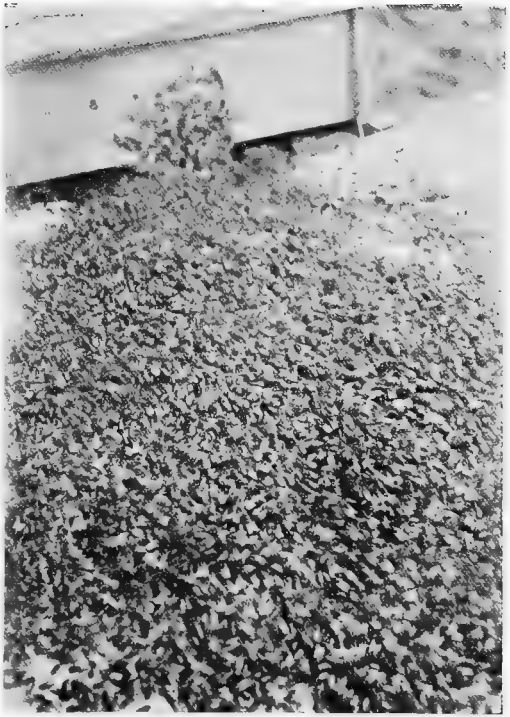
The most formidable amongst these enemies are the Wax Moths. Fragile, feathery creatures though these are, they frequently cause the complete ruin of a colony of bees, when they are permitted to work their destructive will.

There are several kinds, but the most abundant is the *Galleria melonella*, an insect which may be found more or less in all hives during the greater part of the summer.

This moth is a sober-coloured creature, the prevailing shade being a yellowish grey. It is about an inch and a quarter across the wings, the female being somewhat larger than the male and usually darker in colour.

If the entrances of the hives are watched in the evening, after the bees have all retired indoors for the night, the female moth may be seen flitting round the entrance, and with much guile slipping inside unnoticed. She lays her eggs in the comb if she can find one unoccupied by bees, but if not, will be content to deposit them among the refuse

COCOONS OF WAX MOTH.



A LARGE SWARM ENTERING THE HIVE.

A DENSE THRONG.

on the floor. The young caterpillars are very dingy grey objects, with brown heads, and as soon as they are hatched they commence boring into the soft wax, spinning as they go along a lining of silk to their tunnel as a greater protection from the stings of the inmates. When full grown, they are about an inch and a half long, and they enter the pupa stage. To assume this, they emerge from the comb and seek a crevice or obscure corner for the period of repose. They spin a very tough cocoon of silk, and are fond, when possible, of resting thus in little companies. I have noticed that when they spin up on a flat surface, such as the dummy board of a modern hive, behind which there is usually a larger or smaller space unoccupied by bees, they excavate a slight hollow in the wood before affixing their cocoons to it.

In the daytime these moths may often be found hiding in the hives. When disturbed, they run very swiftly into darker corners. I do not know of any species of moth which is so nimblefooted.

Yet another moth which is attracted by bees' hives is the great Death's Head Moth, notable as being the largest species of moth found in Britain. This huge creature used very often to enter the old-fashioned straw bee-hives for the sake of the honey. Into the modern frame-hives I do not think it can possibly find entrance.

Wasps, as I said before, will attack bees in most determined fashion, even to the extent of slaughtering the whole colony and carrying away all its stores. This does not happen, as a rule, unless the hive happens to be weak in numbers, but even strong hives suffer considerably from the attacks of wasps. A favourite trick of the yellow-banded looter is to hang round a hive and wait till some unlucky bee, more heavily laden than most, is unable to alight in the immediate vicinity of the entrance—perhaps falls on the ground. Upon its back the wasp immediately pounces, and too surprised to make any effective resistance, the victim is cut in half at the waist, the wasp bearing off in triumph the abdominal part containing the nectar only just brought home by the poor bee.

In the summer-time ants, too, are often to be seen around and in hives, from whence they no doubt carry away a good store of sweets. The bees do not, so far as I have seen, take much notice of them. They generally enter by odd crevices in the hive body, rather than the entrance itself, and the bees seem to be under the delusion that a hole not big enough for them to get out by will not admit anything big enough to do them harm. May I break the rule I laid down for myself in the beginning, to ask whether there are no parallels to this in the human community?

Earwigs seem very fond of honey, and one turns them out in scores during the summer. It is

improbable that their thefts amount to more than petty larceny.

Spiders are much more troublesome to bees than is, I think, generally supposed. In their methodical search for flowers, particularly at the fag end of the summer, when they are beginning to get scarce, bees are constantly under and around bushes, and the cunningly set snares entrap a good many. The spider has not the smallest respect for the bee, but takes care to avoid the business end by seizing the entrapped insect by the head. She then causes it to revolve by manipulations of the forefeet, and uses it as a spool upon which to wind silk until it resembles a newly swathed mummy.

XIX

PRODUCTS OF BEES

It would astonish most people to realise the full extent of the usefulness of the bee to mankind. Figures seldom convey very much idea of the vastness of things, unless one is accustomed to dwelling with them, but when I say that the value of honey imported into Great Britain alone during one year amounts to about £50,000, it may afford some food for reflection and calculation.

But in Britain itself a very large amount of honey is raised annually by bee-keepers keeping from a single hive to two or three hundred. About forty or fifty pounds of honey per annum is probably the average "take" per hive, although in good seasons a well-managed hive should give much better returns than this. Honey does not, of course, hold quite the same place in our diet as formerly. Before the introduction of sugar, it was practically the only substance available for sweetening purposes, and every farmer and almost every cottager kept a few hives. Now it is looked upon more as a luxury, and few people realise

that it is one of the most wholesome and nutritious of foods.

The same thing may be said, in a less degree, of beeswax, which has been, for many purposes, largely superseded by the cheaper paraffin and vegetable waxes. None of them are of such high quality, however, owing to the fact that it requires a much higher temperature to melt beeswax. We are all familiar with the candles which buckle up on a warm day, and where these profess to be made of wax, it may be taken for certain that not bees' but paraffin wax is the chief constituent.

Quite a number of people seem to think that wax is gathered, like honey, from the flowers. Probably the "waxy" appearance of certain flowers gives rise to this erroneous notion. As a matter of fact, wax is a secretion from the body of the bee, taking place in little pockets, of which there are eight, situated on the underside of the abdomen. The wax issues in the form of transparent pentagonal scales, somewhat like small chips of mica. Before making use of it, the bee mixes it with saliva and grains of pollen, so that wax varies greatly in colour. Some combs are built as white as snow, others have quite a primrose colour.

Wax secretion is believed to be voluntary, and only takes place after the bees have consumed a considerable quantity of food and hung suspended in a high temperature for some time.

In the manufacture of comb proper, and of the cappings with which honey-cells are sealed, bees use wax which is almost pure, but the cappings placed over brood cells and also the walls of queen cells are mixed with a large amount of pollen, so as to make them porous.

Nor is the use of wax confined to the construction of comb. It is frequently used in conjunction with propolis to seal up crevices or cover up objectionable objects which are too heavy for removal.

I have mentioned propolis, which is a resinous substance collected from the buds of trees. I would lay stress on the word "resinous," because most writers speak of it as "gum." Gum and resin are two different things, although somewhat analogous as to origin and purpose. They differ in the important fact that while gums are soluble in water, resin is not. I have tried a good many samples of propolis from different hives, but I have never found any soluble in water, hence it seems clear that bees have an instinct for collecting resin only. Clearly this is the only form which would be of use to keep out water for any length of time, and that it does so may be well illustrated by taking one of the old-fashioned straw hives which has been in use for bees for a few years. It will be found that this receptacle can be filled with water, a feat that would be impossible with a new one.

The chestnut trees are, I believe, a favourite source from which this substance is gathered, and where these are abundant, propolis is freely used. Bees will also frequently collect it from varnished surfaces, and I have frequently seen them carrying it away from an old hive. They transport it in the same way as they do pollen, that is, by packing it into the pollen basket. It has been suggested that a creditable varnish could be obtained from propolis, but it seems hardly worth while taking it in this second-hand fashion, when we are able to procure it from pine trees much more readily.

Pollen, of course, is only another form of farinaceous food, and the amount collected by bees would not be worth taking from them. They consume vast quantities of it, not only for brood rearing, but also as a heat and force-producing element of their own diet.

Pollen is stored in the cells in large quantities just as honey is. It having a very strong tendency to go mouldy, the bees cover up all that is to be kept for winter use with honey, this forming an effectual preservative. Beyond keeping the air out, they do nothing to preserve the honey, which, like all sugary materials, is practically everlasting. A notion has got abroad somehow that in order to assist in keeping the honey, the bees put some of their acid into it. This is giving them credit for more intelligence than they really possess, or, perhaps, it is the other way about.

Great care is taken to see that the fluid is evaporated to the right consistency before it is sealed over, after which it will keep almost indefinitely. Sometimes, when the weather is cold and the outside combs have not been kept sufficiently warm by bees, the honey will candy or granulate into fine crystals. This necessitates some extra trouble in the spring, owing to its having to be redissolved, and water is carried in for this purpose.

XX

CONCLUSION

I HAVE done my best to give a good general outline of the natural history of the honey-bee, and those who have had the patience to follow the subject to the end, will readily agree that the life and activities of the hive are as multifarious and complicated as those of any other natural polity.

Very much remains to be discovered, and although many of our greatest naturalists, as well as thoughtful men in other departments of life, have kept bees and watched them, there is always something fresh to be learned. The mystery of the methods of communication, the exact nature of the sense organs, the curious physiological phenomena connected with the reproduction of the various sexes, these are well-defined problems which provide a wide field of research for those who are prepared to devote their time and energies to systematic and patient observation.

But to the vast majority of bee-keepers, it is not the fascination of research nor the lure of profit that attaches them to these wonderful little creatures. Neither of these would make us *love*

our bees—an expression commonly heard from the lips of the enthusiastic bee-keeper, man or woman.

It is hard, perhaps, to say exactly what it is that evokes this passionate devotion to the craft, more especially as there is no response to it, as is so often seen in the case of such animals as horses and dogs or birds. The most that can be said in that respect is that bees are less likely to sting when handled gently.

Perhaps we may not be very wide of the mark if we think the secret may be found in the words of Kirby, that most patient and persevering, as well as shrewd and intellectual entomologist, to whom the present generation of students owes so much.

"Insects are a book in which whoever reads under proper impressions cannot avoid looking from the cause to the effect, and acknowledging his eternal power and godhead thus wonderfully displayed and irrefragably demonstrated: and whoever beholds these works with the eyes of the body, must be blind indeed if he cannot, and perverse indeed if he will not, with the eye of the soul behold in all his glory the Almighty Workman."—*Introduction to Entomology.*

FINIS

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